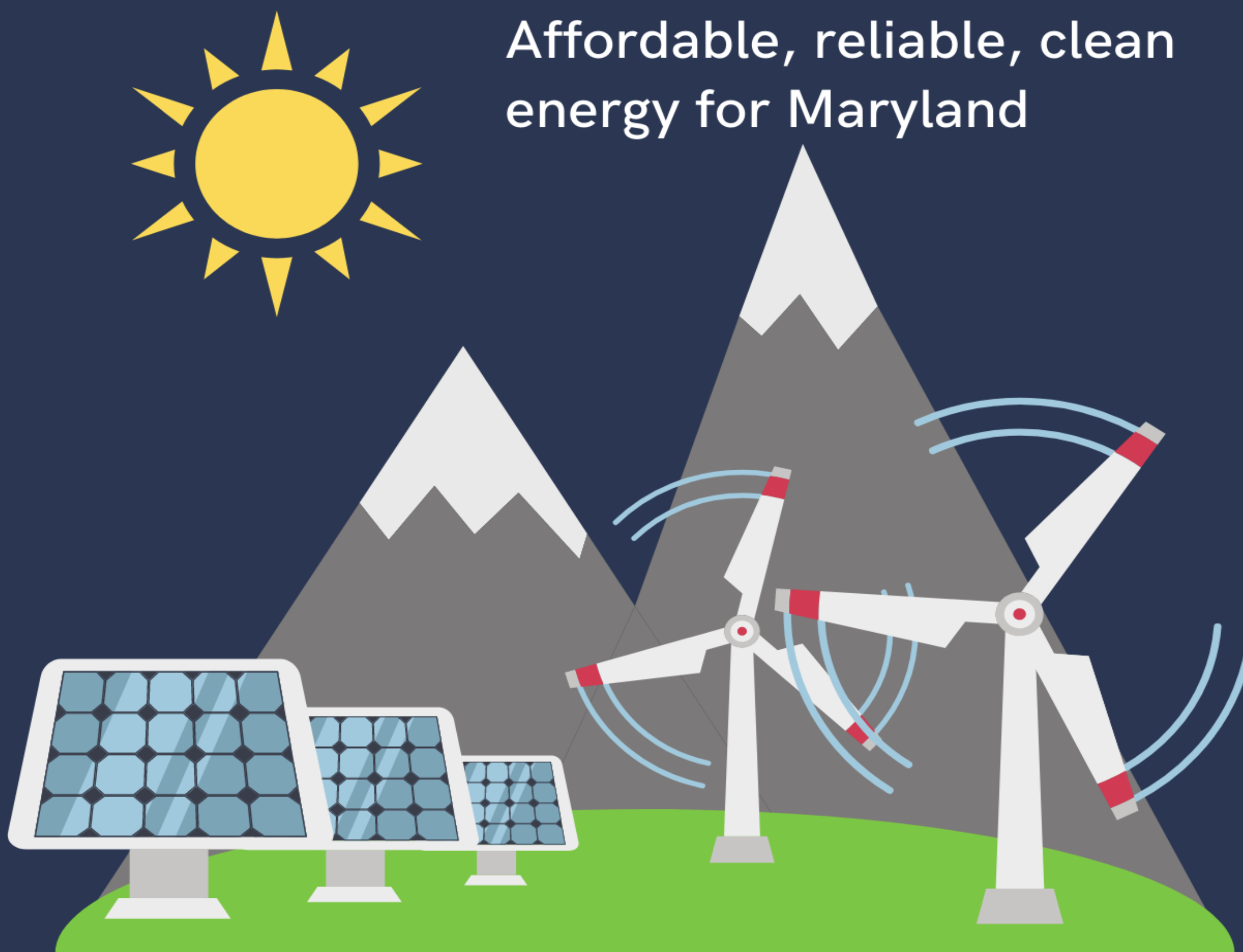
Maryland Energy Administration

Maryland

ENERGY PLAN FOR 2022

Affordable, reliable, clean energy for Maryland



MAY 2022

DEVELOPED BY
Maryland Energy Administration

STATE OF MARYLAND
OFFICE OF THE GOVERNOR

LARRY HOGAN
GOVERNOR

Greetings Marylanders,

Along with the rest of the nation, Maryland's entire energy ecosystem is undergoing a major transformation. As we move towards cleaner, lower carbon energy systems, it is incumbent upon those in public office to do so responsibly, systematically, and in a way that does not create an undue burden on customers nor society. This is a complex transition, revamping the entire engineering system that underpins modern society is complicated as it requires the thoughtful use of a diverse set of data-driven approaches to meet our needs—and the needs of future generations.

While we transition our energy system, a key focus of my administration has been to never lose sight of the fact that Marylanders do not want to pay excessively high rates for energy. This is frequently at odds with the transition in which our state finds itself. Simply put, many of the expenses associated with greenhouse gas (GHG) mitigation do show up on people's monthly utility bills, albeit subtly. A cornerstone to mitigating this is facilitating a more open and transparent market to host a suite of technologies that can provide the emission reductions we need to address climate change while keeping costs low for Marylanders.

Fuel diversity, both within Maryland's aggregate energy economy and amongst the assets that transmit electricity into PJM, which includes emerging, environmentally friendly technologies, is a prudent strategy for meeting the state's challenging emissions goals while keeping energy rates at reasonable levels for consumers. In addition to guarding against higher costs, it is also extremely important we maintain a reliable, resilient and secure energy system so we don't have recurring problems with our grid as seen in other states. Unreliable energy systems are not only inconvenient, but they cost businesses money, and in the worst cases, cost people's lives.

This first-of-its-kind energy plan lays out a flexible framework for Maryland to follow in the years to come, presenting strong action items and associated steps to achieve those goals. This plan does not constrain energy policy or thought leadership. Instead, it requires its custodians to take an iterative approach, revisit the problems we have, and apply new solutions, technologies, and approaches.

Pretending that we have all the answers to this multi-decade problem is not a pragmatic approach to this complex policy problem, but setting a solid and adaptable framework for thoughtful analysis and adaptive policymaking provides the required flexibility to meet one of our society's most pressing problems—power.

Sincerely,

Larry Hogan
Governor

STATE HOUSE, ANNAPOLIS, MARYLAND 21401
(410) 974-3901 1-800-811-8336
TTY USERS CALL VIA MD RELAY

Maryland
Energy
Administration

Hello Marylanders,

During my tenure at Maryland Energy Administration (MEA), the agency has worked to provide a balanced energy transition to all Marylanders. MEA's guiding principle has been to provide cleaner, reliable, and more affordable energy to all residents and businesses. We've struck a pragmatic balance amongst these competing objectives, and it is the intent of this energy plan that the balanced approach to our ambitious goals continues well into the future.

Our state's goals have grown and changed dramatically these past eight years. As custodians of the energy transition underway, it behooves us to maintain a critical eye toward the various available approaches and focus on objectives and actions that are both impactful and achievable. This transition is demanding, and these new demands will place an increased strain on our state and regional energy systems, especially as others throughout the northeast pursue similar goals. A lack of careful consideration of how to manage these changes will make our grid less stable, and Marylanders will be forced to pay higher costs as the grid operators attempt to manage increased demand with fewer resources. Only honest assessments and pragmatic approaches flowing from those accurate, data-driven assessments will allow us to ensure our energy systems are reliable and resilient at the lowest cost to ratepayers.

This energy plan is unique because it has been reviewed and vetted by an array of energy professionals directly involved in bringing cleaner, reliable, and more affordable energy to Marylanders. These people have firsthand experience and knowledge of what it takes to build, maintain, and regulate these complex power systems. Hence, this is a pragmatic document grounded in realism and an honest assessment of Maryland's current place in the energy transition.

As our energy system evolves, it is important to maintain flexibility and recognize that we don't have all the answers about how to approach this energy transition. Some current actions will succeed; others will be more challenging. We must maintain a willingness to learn from our failures, develop new approaches, and continue to move forward; always leaving the door open for newer, better approaches and technologies. Only by maintaining this long-term flexibility can we serve the people of Maryland in the manner which they deserve.

Sincerely,

Mary Beth Tung

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Director
Maryland Energy Administration

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EXECUTIVE SUMMARY

MAY 2022

DEVELOPED BY
Maryland Energy Administration

Executive Summary

Maryland continues to transform how it produces and consumes energy hand-in-hand with other national and global partners. Long-term, overreliance on high-emission energy sources is unsustainable and a clean energy system requires a more flexible and diverse resource base going forward. Maryland has moved at a rapid pace toward that adaptation, with a continual, business-friendly, and low-cost transition of the state's energy sector through both policy actions and the utilization of funds and resources to promote the growth of alternative energy infrastructure.

Maryland has made great strides in decarbonizing its energy sector, resulting in a 28% drop in energy-related carbon dioxide (CO_2) emissions in 2018 from the state's 2005 peak.[1] This progress has been achieved through a multi-year effort targeting a variety of reductions through many means. The mechanisms have involved the 2016 Reauthorization of the Greenhouse Gas Reduction Act (GGRA), continued participation in the regional cap and trade program - the Regional Greenhouse Gas Initiative (RGGI) - continued achievement of EmPOWER Maryland's annual 2% energy consumption reduction target, expansion of the Renewable Portfolio Standard (RPS), advancement of the Zero-Emission Vehicle Program Memorandum of Understanding vehicle targets, and the targeted disbursement of funds from the Strategic Energy Investment Fund (SEIF).

Equally important to the state is the mitigation of excessive costs associated with the energy transition currently underway. The state recognizes that the costs of transforming energy production and consumption should not fall disproportionately on those in our society unable to bear that costly burden. Maryland has made significant funds available to the most underserved and vulnerable, and policymakers constantly review projects and state initiatives to ensure the benefits outweigh the costs to the greatest extent possible.

Bridging the gap between cost and benefit in the energy sector is no easy task. The system that generates, transports, and ultimately delivers energy to households and businesses throughout the state is incredibly complex. Actions in this sector take careful thought and analysis to determine the best way forward. However, it is notable that mitigating the impacts of climate change and reducing carbon emissions does not necessarily result in decreases in economic activity, business formation, or job growth. The general idea that orienting the energy sector to rely less on highly emitting energy sources will hamper business or economic growth is not entirely accurate. Many of the costs associated with this energy transition are, in fact, investments that are capable of driving economic growth and providing well-paying jobs. The figure below shows how emissions have dropped in the state even as the Gross Domestic Product (GDP) continues to grow.

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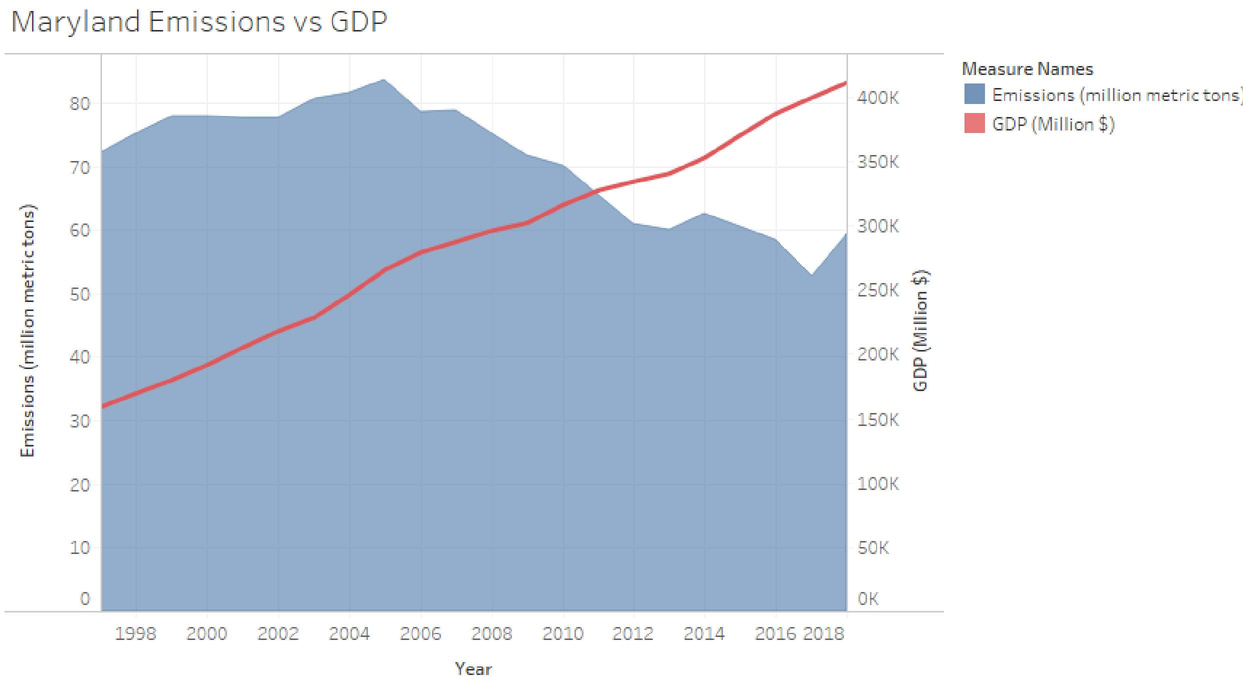
[1] Energy Information Administration, Environment: Energy-Related CO2 Emission Data Tables, Table 1.State energy-related carbon dioxide emissions by year, unadjusted (1990-2018), eia.gov/environment/emissions/state/.

Maryland CO_2 Emissions vs GDP



Source: Maryland Energy Administration (MEA) compilation of U.S. Energy Information Administration and U.S. Bureau of Economic Analysis data.

Maryland's electricity sector had eventful years in 2020 and 2021 with several coal plant closure announcements. Most of the state's coal plants have announced they will either shutter or convert to other fuels, primarily due to the long-term decline in the coal industry that is expected to continue. More pointedly, competition from comparatively lower-cost natural gas has been the main contributing factor to coal's decline.[2] However, natural gas prices have been trending upward more recently. This trend, coupled with the growth in decreasing-cost clean energy and preferences for greenhouse gas (GHG) emission mitigation, appears to present an irreversible decline for the coal industry. Maryland-based coal plants represent some of the highest-emitting sources of CO_2 in the state, and plant closures or conversions will, in many cases, support the state's shift to cleaner energy.

In western Maryland, a new wind project cleared regulatory hurdles necessary for construction; however, the two offshore wind projects have seen delays, resulting primarily from the U.S. Bureau of Ocean Energy Management (BOEM) permitting process.

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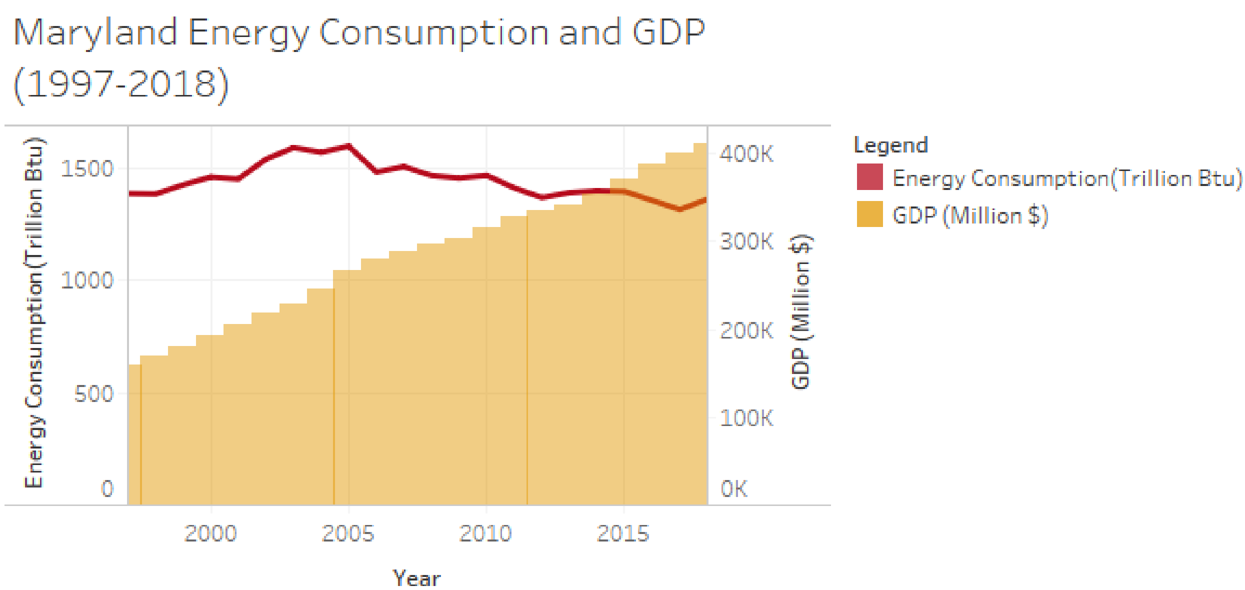
[2] Trevor Houser, Jason Bordoff, Peter Masters, Can Coal Make a Comeback?, 2017, Center on Global Energy Policy, Columbia University, energypolicy.columbia.edu/sites/default/files/Center%20on%20Global%20Energy%20Policy%20Can%20Coal%20Make%20a%20Comeback%20April%202017.pdf.

Another key energy-related element in the state, demand reduction, has once again realized gains. Maryland has been nationally ranked in the top 10 for energy efficiency for the last decade by the American Council for an Energy-Efficient Economy (ACEEE). In 2019, Maryland was acknowledged as the most improved state, and in 2020, the state received its highest ranking to date at sixth place.[3] Similar to reductions in carbon emissions, Maryland has achieved these demand reductions while simultaneously growing the economy, further representing an energy system decoupled from economic growth.[4] These reductions in aggregate energy consumption serve to reduce GHG emissions further.

Maryland Energy Consumption and GDP from 1997-2018



Source: MEA compilation of Energy Information Administration and Bureau of Economic Analysis data.

In the last section of this report, several key action items for the state are enumerated and segmented into short-term and medium-term goals. Maryland can achieve short-term goals within a year or two and medium-term goals in roughly two to five years. These action items range from studies and research to reallocating resources to more beneficial and cost-effective areas to regulatory changes. Notably, these items are achievable and will have a measurable impact on the state's long-term transition to cleaner energy. These items are listed below and elaborated on in the last section of this report. The action items can be initiated and completed

[3] American Council for an Energy Efficient Economy, The State Energy Efficiency Scorecard, aceee.org/state-policy/scorecard

[4] World Resources Institute, America's New Climate Economy: A Comprehensive Guide to the Economic Benefits of Climate Policy in the United States, wri.org/publication/us-new-climate-economy; Overview of the World Resources Institute July 2020 report: Ranking 41 US States Decoupling Emissions and GDP Growth, wri.org/blog/2020/07/decoupling-emissions-gdp-us.

within the given timeframe, and several may only be able to be initiated in these timeframes, owing to unforeseen complications:

Short-term Action Items (one to three years)

1. Support Actions at the Public Service Commission (PSC) for Distribution System Planning
2. Proactive Grid Planning for Distributed Energy Resources (DERs) (Locational Value Study)
3. Mitigate DER System Barriers
4. Encouraging DER Systems as Economic Drivers
5. Strategically Expand Natural Gas Infrastructure
6. Continue Engagement with the Federal Energy Regulatory Commission (FERC) and PJM Interconnection (PJM)
7. Determine Carbon Pricing Impacts
8. Encourage Further Adoption of Combined Heat and Power (CHP) in Key Sectors
9. Determine Modifications to the EmPOWER Program to Manage the Current and Future Unamortized Balance Including the Use of Performance Incentive Mechanisms
10. Adopt Robust Appliance Standards
11. Support the Clean and Renewable Energy Standard (CARES) Legislation
12. Expand Available Offshore Lease Areas
13. Determine Appropriate Approaches of Alternative Fuel Taxation
14. Evaluate the State's Clean Energy Workforce for Growth, Equity, Quality
15. Update the Emergency Fuel Plan
16. Elevate the State's Focus on Energy Security
17. Evaluate How Energy Equity Can Be Further Incorporated into SEIF-funded Energy Programs

Medium-term Action Items (two to five years)

18. Encourage Modifications to Solar Policies and Incentives to Focus on Relieving Energy Burden and Increasing Access to Clean Energy
19. Explore Solar Panel Recycling Best Practices
20. Prepare for Offshore Wind Grid Integration and Storage Management
21. Determine the Potential for a Regional Offshore Renewable Energy Credit (OREC) Market
22. Modify Existing Incentives for Residential Energy Storage
23. Assess Potential In-state Deployment of Small Modular Reactors
24. Encourage the Development of Renewable Natural Gas
25. Establish State Fleet Clean Fuel Policy
26. Explore Alternative Fuel Vehicle Access to Tunnels
27. Consider Possible Adjustments to the RGGI Auction Proceeds Formula
28. Revise the Energy Assurance Plan
29. Introduce Natural Gas Efficiency Goal in EmPOWER

30. Adoption of Building Codes and Training
31. Assess State-wide Energy Burden
32. Develop the Offshore Wind Supply Chain in Maryland in Concert With Regional Partners
33. Develop the State's Regulatory Framework for Carbon Capture and Sequestration

Maryland continues to have ample opportunities to make clean energy investments while creating a net benefit to the economy and society.[5] It is imperative from an economic and social standpoint that the state continues this transition and does so responsibly as it continues its economic recovery and determines the best energy investments to promote business growth, jobs, higher incomes, and environmental goals in the future.

Progress has been made to hasten the state's clean energy transition and reduce carbon emissions in a relatively short period. Despite this progress, there is still more to do to meet the state's long-term goals while simultaneously guarding against high costs, especially to the most vulnerable in the state. A focus on costs and the burden borne by Maryland's residents must be at the forefront of any energy deliberations. While the state continues to manage these complex issues, it continues to move forward on energy responsibly. The State of Maryland is focused on building a resilient energy system based on its strategic goal to transition to a cleaner energy footprint while reducing GHG emissions and maintaining reliability, resiliency, and affordability. The Energy Plan identifies the progress made, the challenges that remain, and steps that could be taken to achieve the state's goals.

[5] For real GDP growth of Maryland: Federal Reserve Bank of St. Louis, FRED Economic Data, Real Total Gross Domestic Product for Maryland, fred.stlouisfed.org/series/MDRGSP.

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INTRODUCTION

MAY 2022

DEVELOPED BY
Maryland Energy Administration

Introduction

Energy plays a vital role in Marylanders' lives, providing power and modern conveniences for residential, industrial, commercial, and transportation applications. There is an increasing need to find ways to generate cleaner energy as the state continues to combat excessive carbon emissions and the associated effects of climate change at a cost acceptable to the state's residents and businesses.

This plan aims to provide an overview of the state of energy in Maryland; inform on state plans addressing a cleaner energy sector while maintaining affordability, reliability, and energy justice; provide a better understanding of statewide energy programs; and end with some actionable recommendations for the state.

Maryland has an exceedingly complex energy system. The state has a wide variety of generation types, characterized by decreasing coal sources and increasing renewables, gas, and nuclear sources. This changing energy mix is only one part of the state's energy landscape. As part of a greater regional transmission network, the state imports roughly 40 to 50% of its electricity from other states in the region.[6] Maryland enjoys low energy intensity (i.e., the amount of energy required for $1 of real economic output),[7] a dependable grid managed by PJM, and increasing use of clean energy resources. This is not accidental and results from coordination and dedication by multiple state agencies and various stakeholders around the state. There are many policies and programs designed to promote affordable, reliable, and cleaner energy for the benefit of all residents of Maryland.

The Maryland Energy Plan provides a framework for Maryland to continue pursuing its energy goals while boosting the state's economy, creating jobs, promoting innovation, protecting the environment, and keeping costs low.

Objectives of the Maryland Energy Plan

The Maryland Energy plan aims to achieve the following objectives:

- Provide an overview of the state's energy landscape.
- Maximize the benefits of energy production and efficient utilization.
- Focus on energy cost savings through efficiency and reducing energy waste.
- Target opportunities to support economic development, market transformation, and job creation by advancing cost-effective innovation and new markets.
- Advocate for the responsible development of energy resources in a way that protects public health and safety, and the environment.

[6] Energy Information Administration, State Electricity Profiles, eia.gov/electricity/state/.

[7] Ibid., Table C10. Total Energy Consumption Estimates, Real Gross Domestic Product (GDP), Energy Consumption Estimates per Real Dollar of GDP, Ranked by State, 2018, Energy Consumption per Real Dollar of GDP, eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/rank_use_gdp.html&sid=US.

- Assure reliable, equitable access to clean and affordable energy while minimizing societal costs.
- Focus on energy security, reliability, and resiliency, ensuring that Maryland's energy needs draw from a variety of resources allowing the state to react more effectively to any market disruptions.

Underlying Maryland's energy initiatives is the reality that these goals should be pursued on a cost-effective basis that takes into account both costs and benefits to society. The need for long-term energy planning is especially pronounced given the complexity and the interdependency of evolving energy infrastructures on the existing electric grid, such as the nexus of increasing distributed, renewable energy generation, electric vehicles (EVs), and battery storage. Many components of energy production and consumption infrastructure - power plants, transmission lines, transportation networks, pipelines, water and wastewater facilities, manufacturing, buildings, and homes - are aging and need upgrades or repairs. This environment provides a real opportunity for more thoughtful energy efficiency and conservation planning for strategic investment in new energy infrastructure, and innovative programs that can help deliver economic, environmental, and improved health benefits throughout Maryland.

A vital part of the expanding menu of energy resources is economic development and job creation. For example, in 2019, Maryland's solar industry consisted of over 4,854 solar-related jobs, including 3,617 jobs related to solar installation.[8] One key element to expanding and growing Maryland's economy is increasing access to cleaner natural gas in rural and underserved areas, such as the Eastern Shore. Natural gas expansion in these areas will provide cleaner energy, address energy access and equity concerns, enhance resiliency, and attract new businesses. In addition, Maryland should continue to focus on a more diverse electricity generation fuel mix that includes in-state renewable resources, hydrogen, carbon capture, and explore options for developing advanced nuclear power. This will ensure resource availability and provide a means to enhance electric grid diversification and reliability by utilizing variable power sources.

Responsible energy planning should consider:

- Long-term cost savings: Efficient use of resources will reduce energy and operating costs, resulting in savings for public and private entities.
- Job creation: Advancing innovation and new markets (local energy sources such as renewables and natural gas) will generate a demand for a skilled workforce in sales, installations, manufacturing, and operations.
- Economic growth: Energy planning should promote a favorable regulatory and investment climate that attracts new businesses to the state, creates new jobs and encourages increased investments from industry players.

[8] The Solar Foundation, Solar Jobs Census 2019: Maryland, thesolarfoundation.org/solar-jobs-census/factsheet-2019-md/.

- Environmental benefits: Reducing energy intensity (i.e., the relative amount of energy required to produce each dollar of state GDP) or switching to low or zero-emissions energy sources that contribute to healthy water, soil, and air resources will have a variety of direct and indirect beneficial effects on health care, recreation, and other community-related concerns.
- Security, reliability, and resiliency: Ensuring that Maryland's energy needs draw from various clean and renewable resources that will allow the state to react more effectively to market disruptions.
- Approaches to mitigate statewide energy burden: developing an understanding and ensuring policy decisions consider their distributional impact throughout society will be imperative to alleviating statewide burden.

The responsible transition from fossil-fuel electricity generation to cleaner and low-carbon energy generation resources will benefit Maryland citizens with cleaner air and new economic opportunities. Renewable power sources - solar, wind, hydroelectric power, low-temperature geothermal, and other low carbon and carbon-free solutions - will continue to grow with the assistance of federal, state, and local programs.

Maryland's Strategic Vision for Energy

There must be a diversification of Maryland's power generation portfolio beyond where it is today to achieve Maryland's clean energy goals. Increased penetration of multiple clean energy assets is critical to attaining these goals. Jurisdictions from California to Germany are embarking on further diversification campaigns, opening the clean energy field to new technologies that achieve the ultimate goal of CO_2 emissions reductions. Diversification and flexibility towards meeting the state's goal of cleaner energy generation with reduced GHG emissions should form the cornerstone of its path forward, so our energy systems can better adapt and be operationally flexible.

The ultimate energy goal of the state is:

To transition to a cleaner energy footprint while maintaining reliability, resiliency, and affordability.

Towards that end, MEA has identified the following guiding principles for the state:

- Encourage maximum energy efficiency whenever and wherever it is cost-effective.
- Assist the development of clean energy resources in the power generation sector while strategically using natural gas as a load-balancing tool.
- Pursue energy storage options to provide reliability under a grid with a significant variable renewable energy component.
- Take advantage of the energy transition by generating well-paying jobs.
- Pursue smart grid technologies to maximize electric system reliability and resilience.

- Pursue distributed energy resources (DERs) and microgrids that protect critical infrastructure and critical services for the general public.
- Ensure clean energy and energy efficiency benefits reach all segments of the population.
- Encourage infrastructure deployment to support zero-emission vehicles, starting with light-duty vehicles along high usage transportation corridors, home charging for multi-family housing units (apartments, condominiums, public housing, etc.), hydrogen filling stations, and green hydrogen generation.
- Communicate key elements of this plan to the general public.

Following diverse pathways to decarbonizing the energy sector will be the only cost-effective and time-sensitive way forward for meeting the state's goals. Other states and countries are already beginning such expansions. For instance, California and countries such as Norway are carrying out drastic expansions of carbon capture technology (in March 2021, California also announced a joint project between Microsoft, Chevron, and Schlumberger to build a new carbon capture plant),[9] and Germany is ramping up incentives for hydrogen production, and recently announced projects for wind turbines to generate clean hydrogen through their operation.

While Maryland continues to pursue and ardently push for solar and wind deployment, it recognizes that deploying these weather-dependent technologies' does not come without difficulties, ranging from intermittency to land use issues. Despite great gains in deploying renewable technologies and reducing electricity demand through efficiency gains, the demands on energy systems are set to increase, especially with greater fleet electrification and EV penetration as well as a growing population and greater use of electric devices and HVAC systems. This will undeniably place new strains on our energy systems, and our systems must be able to manage and accommodate those demands.

Furthermore, increased climate variability, including extreme heat and cold, will increase electricity load and infrastructure demands. One example of this situation arose with the intense heat and wildfires witnessed in California. Due to a confluence of factors, the California Independent System Operator (CAISO) was unable to maintain grid stability due to these climate change-induced weather events and had to institute forced blackouts to accommodate the strain. CAISO's inability to bring on sufficient generation in the early evening peak (after solar's steep, afternoon drop in electricity generation),[10] joined with deficiencies in their

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[9] California has a large negative emissions focus through the development of bioenergy with carbon capture and storage (BECCS). Basic primer on BECCS: American University, Fact Sheet: BECCS, american.edu/sis/centers/carbon-removal/fact-sheet-bioenergy-with-carbon-capture-and-storage-beccs.cfm ; Also, main page for Lawrence Livermore National Laboratory (LLNL) study on BECCS in meeting California's climate goals: Getting to Neutral Options for Negative Carbon Emissions in California, llnl.gov/news/new-lab-report-outlines-ways-california-could-reach-goal-becoming-carbon-neutral-2045; Reuters, "Chevron to build California carbon capture plant with Microsoft, Schlumberger," March 4, 2021, reuters.com/article/us-chevron-renewables-mendota/chevron-to-build-california-carbon-capture-plant-with-microsoft-schlumberger-idUSKBN2AW1UB.

[10] California Independent System Operator (CAISO), What the duck curve tells us about managing a green grid, caiso.com/Documents/Flexibleresourceshelprenewables_FastFacts.pdf.

day-ahead market,[11] ultimately restricted supply to the point that the 15% reserve[12] was insufficient.[13]

Diversifying the Maryland energy system through new generation sources will be essential to meeting the state's goals.[14] Realizing advantages to the state and encouraging those strengths will be critical to meeting our energy goals. This push for diversification will include proven, revamped technologies such as nuclear (advanced technologies such as small modular reactors) and geothermal technologies, the utilization of gray, blue, and green hydrogen[15] in both the power and transportation sectors,[16] and the use of carbon capture and storage (CCS) technologies in both the power sector and energy-intensive industries (a sector traditionally ignored when determining CO_2 emissions strategies).[17] Additionally, as costs come down, the strategic application of energy storage technologies and direct air capture (DAC) systems, which collect existing CO_2 in the atmosphere for sequestration, may be necessary.

A holistic and comprehensive perspective of the energy system is critical, especially as the state increases its renewable energy penetration. The state's natural gas system and associated infrastructure are crucial to renewable energy expansion and cannot be thought of as stand-alone systems for simple emissions-based comparisons. Instead, it must be thought of in terms of the overall electricity system and the systemic impact on pricing, reliability, and ultimately the increased penetration of renewable generation. Natural gas systems provide multiple benefits for a cleaner energy transition allowing higher penetration of renewables, using facilities augmented with carbon capture technology and gas-related equipment.[18] Natural

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[11] Ibid., Market processes and products, caiso.com/market/Pages/MarketProcesses.aspx.

[12] Ibid., Resource Adequacy Enhancements Second Revised Straw Proposal, caiso.com/InitiativeDocuments/SecondRevisedStrawProposal-ResourceAdequacyEnhancements.pdf, 11-15.

[13] Final joint report: California Independent System Operator (CAISO), California Public Utilities Commission (CPUC), and California Energy Commission (CEC), Final Root Cause Analysis: Mid-August 2020 Extreme Heat Wave, January 13, 2021, caiso.com/Documents/Final-Root-Cause-Analysis-Mid-August-2020-Extreme-Heat-Wave.pdf.

[14] Benjamin Matek and Karl Gawell, The Benefits of Baseload Renewables: A Misunderstood Energy Technology, *The Electricity Journal*, Volume 28, Issue 2, March 2015, 101-112, sciencedirect.com/science/article/pii/S104061901500024X.

[15] S&P Global, Infographic: Sustainable hydrogen: blue and green pathways to decarbonization, spglobal.com/platts/en/market-insights/latest-news/electric-power/020320-sustainable-hydrogen-blue-and-green-pathways-to-decarbonisation.

[16] International Energy Agency, The clean hydrogen future has already begun, iea.org/commentaries/the-clean-hydrogen-future-has-already-begun.

[17] It should be noted, the 2019 European Green Deal highlights increased support for hydrogen and carbon capture technologies: eur-lex.europa.eu/legal-content/EN/TXT/?qid=1596443911913&uri=CELEX:52019DC0640#document2 ; EU strategy document for Europe from July 2020: eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0301 ; Germany alone is investing €9 billion: dw.com/en/germany-and-hydrogen-9-billion-to-spend-as-strategy-is-revealed/a-53719746.

[18] More information and supporting information in the natural gas section, but this McKinsey document shows the necessity and potential use of natural gas: McKinsey and Company, The Future of Natural Gas in North America,

gas generation has CO_2 emission rates far below coal and petroleum facilities. Maintaining natural gas infrastructure is also more important now, given the fact that five of the six remaining large coal plants in the state declared in 2020 that they would either shut down or convert to other fuels. Today's transmission and distribution systems are technologically similar to systems used 100 years ago, which means there is still a strong reliance on flexible, dispatchable technologies like natural gas. Upgrading and modifying existing electricity infrastructure to accommodate more renewable energy to meet future demands is a complex and costly task that will not happen quickly.

The state is also not in complete control of the energy consumed within its borders, which means regional partnerships will increase in importance, especially as the state reasserts sovereignty on power issues before the FERC and PJM, making clear state priorities for clean energy deployments. Given Maryland's location, regional coordination is both logical and essential given the state's ultimate dependence on other PJM states for electricity. As part of a complete strategy, the state must focus on coordinating and working with its regional partners as much as possible, forming complementary partnerships that help it achieve greater clean energy gains than it would on a state-by-state basis.

Maryland is committed to moving toward an energy system that properly values low carbon generation while maintaining the same reliability and cost-effectiveness standards that have influenced planning parameters in the past. This is an achievable goal, but the state must be willing to make adjustments to its current system and remain open to new technologies and approaches over time. Clean and renewable energy systems currently in development (or maturing) will enable the state to move forward responsibly.

Impact of COVID-19 on Maryland's Energy System

The COVID-19 pandemic and subsequent economic recovery significantly affected employment, energy services, and energy demand in Maryland. The State of Maryland is committed to helping businesses, communities, and residents access clean, affordable, and reliable energy as the state recovers from pandemic-related impacts. By December 2020, Maryland had lost 8,499 clean energy jobs that existed before the pandemic. This cumulative job loss represents an estimated 10% decline in the state's clean energy industry. The most significant job losses came from the energy efficiency sub-sector, which accounted for about 85% of total Maryland energy industry job losses.[19] While many of these jobs have since recovered, the breadth of pandemic-related impacts remains uncertain—e.g., the overall loss of positions, impacts to

mckinsey.com/industries/electric-power-and-natural-gas/our-insights/the-future-of-natural-gas-in-north-america ; Energy Information Administration, U.S. Energy-Related Carbon Dioxide Emissions, 2019, eia.gov/environment/emissions/carbon/.

[19] BW Research Partnership, Clean Energy Employment Initial Impacts from the COVID-19 Economic Crisis, December 2020, Prepared for E2 (Environmental Entrepreneurs), E4TheFuture and the American Council on Renewable Energy (ACORE) retrieved from: e2.org/reports/clean-jobs-covid-economic-crisis-december-2020/.

minority and women-owned businesses, and impacts to overall wage equity.[20] MEA, as part of its workforce assessment with the National Association of Energy Officials (NASEO), will help understand these impacts and what actions are necessary to ensure a robust and equitable energy industry.

Several actions were taken to mitigate the negative impacts of COVID-19 in the energy sector, including a new docket at the PSC addressing pandemic impacts and providing an avenue for additional rate relief. Additionally, on February 15, 2021, Governor Hogan signed the bipartisan RELIEF Act into law, which delivered more than $1 billion in tax relief and economic stimulus for families and small businesses. The law allocates tens of millions of dollars to the PSC and directs the Commission to utilize the funds as grants to utilities to help reduce or eliminate household utility arrearages. Shortly after, the PSC issued its order distributing the allocated resources under the RELIEF Act.[21] Arrearage assistance exceeded $80 million for Maryland residential ratepayers.[22] The PSC also set the sunset date for the moratorium on utility shut offs to "after the later of November 1, 2021 or 30 days after the date when all funds granted by this Order to that Utility have been applied in full to customer arrearages, [at which time] the moratorium shall be lifted and the Utility may resume disconnection activities in accordance with the Commission's established regulations."[23]

Current Energy Profile

In 2018, 1,361 trillion British thermal units (Btu) of energy were consumed in Maryland.[24] More than 80% of the energy consumed in Maryland is imported (this is both electricity and other energy sources, including fuels). The aggregate of primary energy produced in Maryland amounts to an estimated 253 trillion Btu, with nuclear energy making up over 60% of that total. [25] Maryland has the 10th lowest energy consumption per capita and the 8th lowest energy intensity of the 50 states.[26] Energy is utilized for residential, commercial, industrial, and transportation purposes. Residential, commercial, and transportation each amount to about

[20] By the end of 2020, nearly half of the clean energy jobs lost in the United States due to COVID-19, had recovered, and overall losses to Maryland were 7.9%, with 8.2% growth from June-December 2020: BW Research Partnership, Clean Jobs America 2021, e2.org/wp-content/uploads/2021/04/E2-2021-Clean-Jobs-America-Report-04-19-2021.pdf, 6.

[21] MD PSC Order 89856.

[22] Id. at 17

[23] Id. at 15.

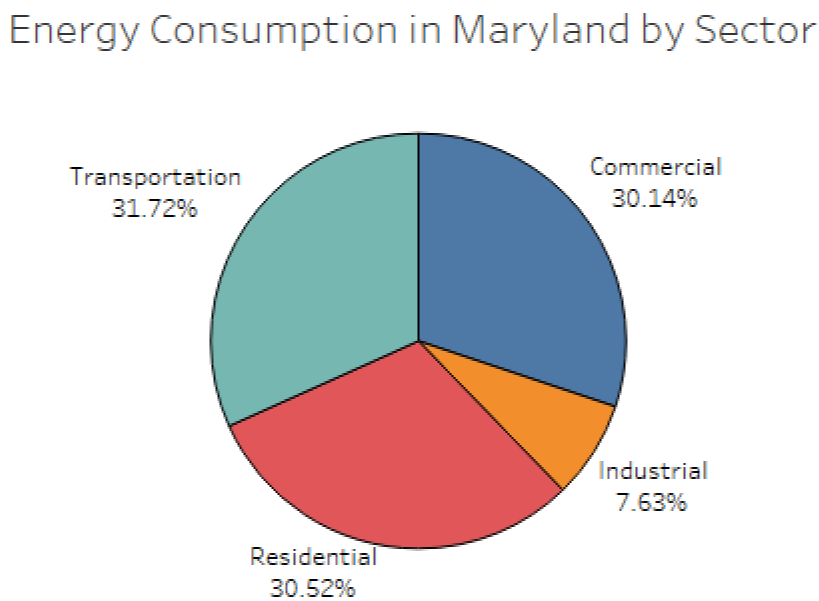
[24] Energy Information Administration, Maryland Profile Analysis, eia.gov/state/data.php?sid=MD#ConsumptionExpenditures.

[25] Ibid,Rankings: Total Energy Production, 2018 (trillion Btu), eia.gov/state/rankings/?sid=US#/series/101; Ibid, SEDS State Energy Data, eia.gov/state/seds/sep_prod/xls/P2.xlsx.

[26] U.S. EIA, State Energy Data System, Table C14, Total Energy Consumption per Capita by End-Use Sector, Ranked by State, 2018; Ibid., Table C10, Total Energy Consumption Estimates, Real Gross Domestic Product (GDP), Energy Consumption Estimates per Real Dollar of GDP, Ranked by State, 2018.

30% of total energy consumption, with industrial applications accounting for the remaining 10%.[27]

2018 Energy Consumption by Sector



Source: Energy Information Administration, Maryland Profile Analysis, eia.gov/state/data.php?sid=MD#ConsumptionExpenditures.

Energy consumption in Maryland is dominated by fossil fuels, which made up 65% of total energy use in 2018. The most used fuels were petroleum products and natural gas, which made up 33% and 23% of our energy consumption, respectively. Other important fuels include nuclear, coal, and renewable sources, making up 11%, 9%, and 7% of energy consumption, respectively. The remaining 17% is the net interstate flow of electricity, which is the difference between the sum of electricity sales and losses within a state and the total electricity generated within Maryland.[28]

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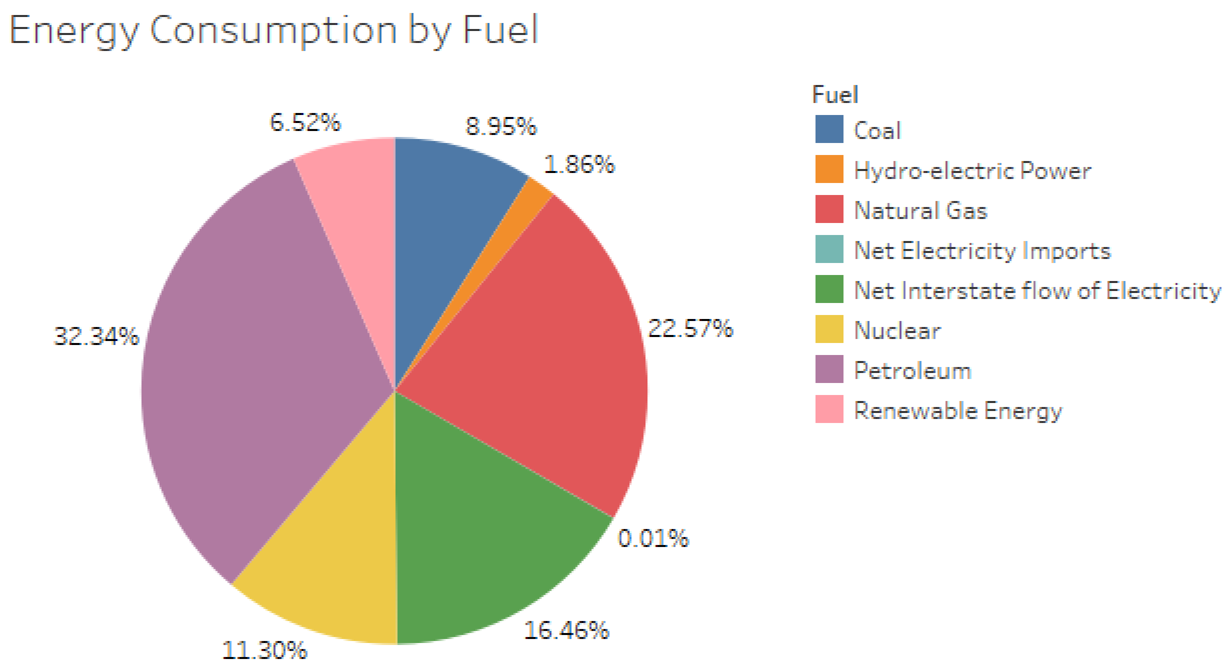
[27] Ibid., Maryland Profile Overview, eia.gov/state/?sid=MD.
[28] Ibid., Table C1. Energy Consumption Overview: Estimates by Energy Source and End-Use Sector, 2018 (Trillion Btu), eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/sum_btu_1.html&sid=US.

2018 Energy Consumption by Fuel



Source: Energy Information Administration, Maryland Profile Analysis, eia.gov/state/data.php?sid=MD#ConsumptionExpenditures.

Between 1960 and 2005, the state's energy consumption rose at an average of 2.1% annually. Energy consumption peaked in 2005 at 1,596.8 trillion Btu and has been falling since. Energy consumption dropped by approximately 15% between 2005 and 2018.[29] Some of the factors responsible for this include the 2008 economic recession, the growth of energy efficiency, the transition from coal to natural gas for electricity generation,[30] and residential applications.[31] Like nationwide trends, GDP and population growth in Maryland do not positively correlate to energy consumption as in past decades. As can be seen in the following graph, despite increasing GDP and population, Maryland's overall energy consumption has been on a steady decline, partly due to the state's comprehensive actions on energy efficiency and conservation.

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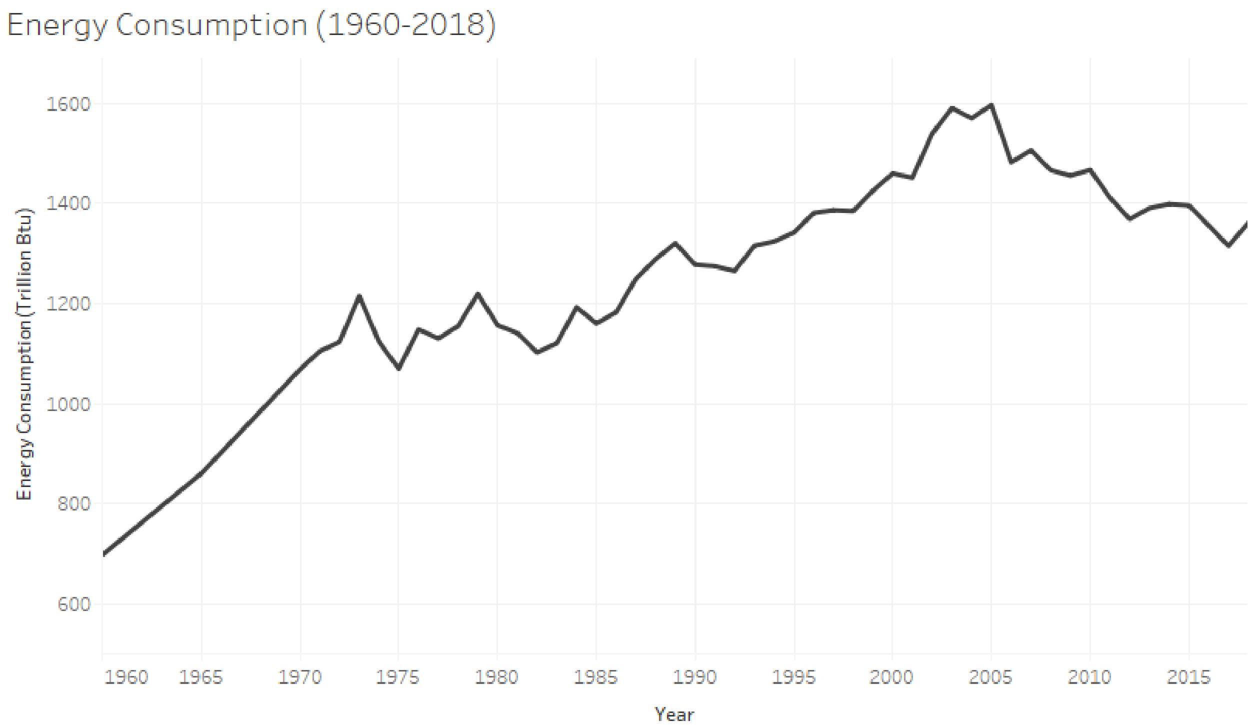
[29] Ibid., Maryland: State Energy Data System (SEDS): 1960-2018 (complete), eia.gov/state/seds/seds-data-complete.php?sid=MD#Consumption.

[30] Due to increases in efficiency over other generation types. See: Ashok D. Rao, *Combined Cycle Systems for Near-Zero Emission Power Generation*, (Woodhead Publishing, 2012). Abstracts: sciencedirect.com/book/9780857090133/combined-cycle-systems-for-near-zero-emission-power-generation#book-info.

[31] In-home installation and use of products like smart thermostats.

1960-2018 Energy Consumption

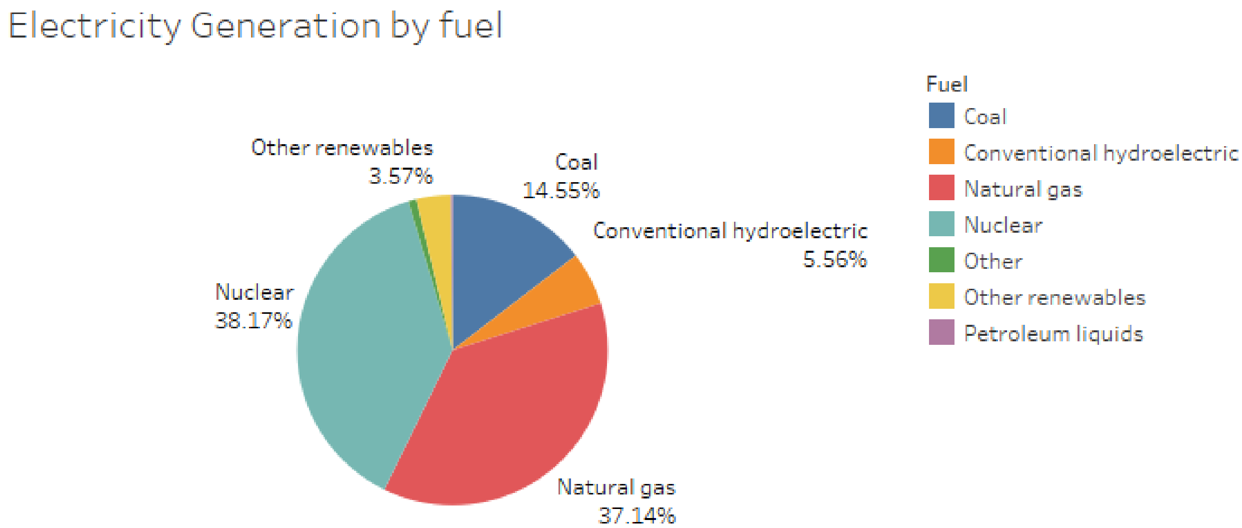


Source: Energy Information Administration, Maryland Profile Analysis, eia.gov/state/data.php?sid=MD.

In 2019, an estimated 39,328,689 megawatt-hours (MWh) of electricity were generated in Maryland. Nuclear and natural gas were the dominant fuels for electricity generation in Maryland, making up about 75% of net electricity generation. Both fuels accounted for roughly the same amount of generation. Coal, hydroelectric, and renewables make up most of the balance. About 38% of net electricity generation comes from Maryland's only nuclear power plant, Calvert Cliffs, located in southern Maryland. The plant's current operating license expires in 2034. The proportion of natural gas generation has more than doubled since 2016, rising from about 14% in 2016 to 37% in 2019. On the other hand, the proportion of coal generation dropped in the same period, falling from 37% in 2016 to 14% in 2019.[32]

[32] Energy Information Administration, Net generation (megawatt hours), eia.gov/electricity/state/Maryland/.

2018 Electricity Generation by Fuel



Source: Energy Information Administration, Maryland Profile Analysis, eia.gov/state/data.php?sid=MD.

Electricity generation from renewable energy other than hydropower has grown rapidly in recent years. Factors responsible for this growth include decreases in the cost of clean energy and policies such as the RPS. Utility solar grew from 80 MWh in 2010 to 494,311 MWh in 2019. Wind generation grew from 1,494 MWh in 2010 to 520,269 MWh in 2019.[33]

[33] Ibid., Maryland: State Energy Data System (SEDS): 1960-2018 (complete), eia.gov/state/seds/seds-data-complete.php?sid=MD.

Maryland Energy Administration

Maryland

ENERGY POLICY DRIVERS

MAY 2022

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Energy Policy Drivers

Introduction: Statutory Provisions Impacting Maryland's Energy Policy

Maryland has several binding statutory provisions that enable the state to move toward a cleaner and more renewable energy system. These mandates generally target different components of the economy to address energy and climate concerns. However, even with statutory provisions directing movement on many energy issues, the prevention of excessive costs assessed to Maryland's ratepayers is a high priority. The state's mission continues to seek out the most cost-effective paths to achieving these goals. The most pertinent statutes impacting energy in the state are outlined below.

In 2016, as an overarching mandate for GHG emissions, the state reauthorized the Greenhouse Gas Reduction Act (GGRA) of 2009, establishing a new target to reduce emissions by 40% below 2006 levels by 2030. This target was recently increased to 60% as a result of the Climate Solutions Now Act of 2022. The state also participates in the RGGI, a multi-state cooperative effort to reduce CO2 emissions generated by fossil fuel-fired power plants by 30% over the 2020 to 2030 period.[34]

Directly targeting energy generation, the state has a Renewable Portfolio Standard (RPS), which was enacted in 2004, amended several times, further expanded in 2019, and again in 2021. The RPS requires electricity suppliers to procure a minimum portion of their retail electricity sales from qualified renewable energy sources. Electricity suppliers show compliance by accumulating renewable energy credits (RECs) equivalent to the minimum percentage of sales established in the RPS for each calendar year. The current Maryland RPS is 50% renewable energy by 2030 with specific carve-outs for solar, offshore wind, and geothermal resources.

Additionally, through the EmPOWER program, the state has statutorily required goals for energy efficiency.[35] Through the CY15, the State of Maryland had a goal to reduce per capita electricity and peak demand by 15% over a 2007 baseline. In 2017, state energy efficiency legislation was updated to require the PSC to oversee cost-effective energy efficiency programs with a target of achieving at least 2% annual incremental gross energy savings, based on 2016 weather-normalized gross retail sales and electricity losses.[36] This program continues to evolve.

MEA advises on energy policy and administers the SEIF, which encompasses proceeds from multiple sources, including revenues from RGGI auctions. Statutorily-required uses of RGGI proceeds include:

- energy efficiency, with at least 50% dedicated to low and moderate-income (LMI) energy efficiency;

[34] RGGI, Inc., Elements of RGGI, rggi.org/program-overview-and-design/elements.
[35] General Assembly of Maryland, Public Utilities Article, §7–211.
[36] Senate Bill ("SB") 184 / House Bill ("HB") 514.

- renewable energy, clean transportation, and climate change;
- energy bill assistance, and energy-related job training, among other uses.

The formula for using SEIF funds is as follows:

1. at least 50% for energy assistance through the Electric Universal Service Program (EUSP) and other electricity assistance programs in the Department of Human Services (DHS) (i.e., energy bill assistance)
2. at least 20% shall be credited to a low and moderate income (LMI) efficiency and conservation program account and to an account for general energy efficiency and conservation programs, projects, or activities and demand response programs, of which at least one–half shall be targeted to the LMI efficiency and conservation programs
3. at least 20% for renewable and clean energy programs
4. up to 10%, but not more than $5,000,000, for administrative expenses

Although the SEIF has received funding from PSC orders and RPS Alternative Compliance Payments (ACPs) in the past, proceeds from these sources have been minimal in most fiscal years. SEIF is used by MEA and other state agencies to implement energy and climate change-related programs. SEIF-funded efforts help reduce household and business energy bills while addressing climate change, job creation, economic development, and energy independence.

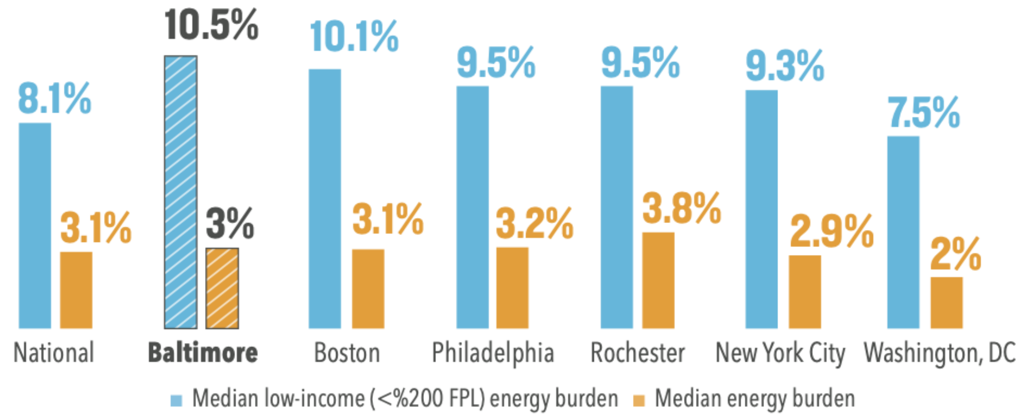
The Protection of Maryland's Ratepayers

Most public policy actions carry costs, directly or indirectly. The energy sector is no different, except many of these costs are investments over the long-term when properly applied and executed.

Sometimes, these energy investments are covered by direct payments from the state government (e.g., from the general fund's tax revenues or incentive programs with funds derived from various sources). However, more frequently, these investment costs are borne more directly by Maryland's ratepayers through their utility bills. These costs show up through increases in household electricity rates. Since these costs are evenly distributed to households throughout a utility territory, they ultimately increase the energy burden of those households that can least manage such increases, presenting significant challenges to energy policymakers. Many of the costs for these projects are also front-loaded earlier in the investment period, with households and society only receiving the benefits later. Furthermore, low-income families disproportionately absorb the full effect of these costs as a percentage of their income compared to higher-income households. These poorly distributed costs create many legitimate societal problems. In the Baltimore metropolitan area, the median low-income energy burden is 10.5% compared to the general Maryland median energy burden of 3%.[37]

[37] For example, see some of the energy burden in Baltimore: American Council for an Energy Efficient Economy, Energy Burdens in Baltimore,

Median Low Income Energy Burden vs. Median Energy Burden



Source: Figure reproduced from ACEEE

While it is necessary to move the state and our society towards a cleaner and more renewable energy paradigm to clean up our environment and reduce GHG emissions, the state must balance these efforts against unnecessary and excessive costs to Maryland's residents and businesses. There are many programs, initiatives, and investments where the two goals of clean energy and minimal costs are not mutually exclusive; indeed, many seemingly costly upfront investments will drive greater benefits in the future. However, in certain circumstances, the funding may be better applied to achieve the desired results. The state will continually seek out the best, lowest-cost applications of scarce resources throughout the state, working to safeguard the households and businesses from burdensome costs.

Greenhouse Gas Emissions Reductions Goals

Senate Bill 323, signed into law in 2016, reauthorized existing statute to reduce the state's GHG emissions from 25% by 2020 to 40% by 2030 (below 2006 levels). Maryland met the initial 2020 goal, originally set through legislation in 2009. The follow-up legislation was then passed based on need and the severity of the situation. Many state agencies work in concert toward achieving this goal, along with households and businesses all over the state. Both the electricity and transportation sectors contribute significantly to the state's GHG emissions and the state is continually working to assist in the reduction of carbon emissions from these sectors, through multiple programs and activities, explained in this document.

Recently, the Climate Solutions Now Act (2022) was adopted as law.[38] The law contains several measures aimed at reducing intrastate GHG emissions. Measures include efforts to electrify the buildings sector, establishing goals for the state's electric distribution system planning to better align with GHG reduction goals, and to increase resilience and reliability. The legislation raises

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aceee.org/sites/default/files/pdfs/aceee-01_energy_burden_-_baltimore.pdf; For a broader look at energy burden: ACEEE, Energy Burden, aceee.org/energy-burden.

[38] Ch. 38 of the Laws of Maryland 2022.

the state's overall goal for GHG emission reductions target to 60% by 2031 and to net-zero emissions by 2045.

Under the law, MEA must establish a Climate Transition and Clean Energy Hub to serve as a clearinghouse for information related to new GHG reduction programs and to provide technical assistance for new, more stringent building performance standards. MEA and the PSC are tasked with coordinating with utilities to maximize utilization of federal funds available for electric distribution planning and development including programs stemming from the Infrastructure Investment and Jobs Act. Furthermore, MEA, several other state agencies, and other interested stakeholders, are to participate in up to four of the newly established working groups within the Maryland Climate Change Commission. Those working groups include a Just Transition Employment and Retraining Working Group to examine workforce development and training as well as net job creation as it relates to the implementation of the Act, an Energy Industry Revitalization Working Group to examine the effects upon and opportunities for small businesses in the course of the continued and accelerated transition to clean energy, an Energy Resilience and Efficiency Working Group examining the resiliency of the transmission and distribution grids, and the role of battery storage, and a Solar Photovoltaic Systems Recovery, Reuse, and Recycling Working Group which will examine the end of useful life opportunities for the materials utilized in solar photovoltaic systems.

Additionally, the Act alters the Chesapeake Conservation Corps Program, prohibits the use of a school bus that is not a zero-emission vehicle after a certain date and with limited exception, creates an Electric School Bus Pilot Program administered by the PSC which allows an investor-owned utility to propose a program to obtain zero-emission school buses and the associated infrastructure for use in the state, alters the Community Solar Pilot Program, requires that 100% of state-owned light-duty vehicles be zero-emission vehicles by a certain date with limited exception, extends and expands the EmPOWER program, among several other provisions.

Maryland's Renewable Portfolio Standard (RPS)

Maryland's RPS was established in 2004 to foster a market for renewable energy in Maryland by providing financial incentives for new renewable generation. The RPS program requires electricity suppliers to accumulate RECs equal to the statutorily established percentage of retail electricity sales in Maryland for each compliance period. One REC equals one MWh of electricity generation from a qualified renewable energy resource.

Under the RPS, qualified renewable resources are classified into two categories: Tier 1 and Tier 2. Tier 1 resources include solar, wind, qualifying biomass, methane from a landfill or wastewater treatment plant, poultry litter-to-energy, geothermal, ocean, waste-to-energy, refuse-derived fuel, thermal energy from a thermal biomass system, certain fuel cell technologies, and any hydroelectric power plant with a capacity of 30 MW or less. The Tier 2 resource category, including hydroelectric power plants that do not employ pumped storage generation, was sunset at the end of 2018; however, legislation passed during the 2021 legislative session that reinstated this category.[39]

The RPS program guidelines require electricity suppliers to retire RECs equivalent to minimum levels of qualified renewable resources, which gradually increase over time. The failure to file the required number of RECs at the end of each compliance period results in a financial penalty known as an ACP, which electric suppliers must pay per required MWh. In turn, any penalties collected for noncompliance are used to support the creation of new Tier 1 renewable resources within the state; however, historically, these amounts have been minimal.

Currently, Maryland's RPS is 50% of retail electricity sales by 2030. The RPS includes three specific Tier 1 targets or carve-outs: a 14.5% carve-out for solar generation by 2030, and a 1,200 MW additional carve-out for offshore wind (in addition to the existing approved 368 MW).[40] In 2021 Maryland legislators added the third carve-out category for geothermal systems, starting in 2023, with a 1% requirement. In order to be eligible, qualified renewable energy, non-carve-out generators must be located within Maryland, the PJM regional transmission area or areas adjacent to PJM through transmission interconnections.

In 2018, the Maryland Department of Natural Resources (DNR) Power Plant Research Program (PPRP) conducted a study addressing the RPS. PPRP was directed to conduct a comprehensive review of the history, implementation, overall costs, and benefits and the effectiveness of the Maryland RPS in relation to the energy policies of the state, including the availability of all clean energy resources at reasonable and affordable rates, and including in-state and out-of-state renewable energy options. More broadly, PPRP examined whether Maryland is likely to meet its existing goals under the current RPS and if the state were to increase these goals, whether electricity suppliers should expect to find an adequate supply to meet the additional demand for credits and whether the RPS can meet current and potential future targets without the inclusion of certain technologies. This report was ultimately delivered to the General Assembly in 2019.[41] Some of the major conclusions from the report include:

1. Maryland RPS requirements have been achieved at relatively reasonable and affordable costs, representing at most 1.8% of retail electricity bills.
2. There is a diverse mix of fuels making up the RECs retired for Maryland RPS compliance.
3. Maryland RPS has resulted in modest reductions in GHG emissions, but some fuels, such as black liquor, landfill gas, and municipal solid waste, included in the RPS may increase nitrogen oxides (NOx) and sulfur dioxide emissions.

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[39] Senate Bill 65, mgaleg.maryland.gov/mgawebsite/Legislation/Details/SB0065?ys=2021RS.
[40] MDPSC, Renewable Energy Portfolio Standard Report, October 2020, psc.state.md.us/wp-content/uploads/CY19-RPS-Annual-Report-Final-1.pdf.
[41] Maryland Department of Natural Resources, Maryland Renewable Portfolio Standard (RPS) Study, dnr.maryland.gov/pprp/Pages/RPS-WorkGroup.aspx.

4. Maryland RPS has also resulted in modest economic development in the state, including providing jobs with higher than average wages.

Regional Greenhouse Gas Initiative (RGGI)

Maryland is a member of RGGI, which is the first mandatory market-based, regional program in the U.S. designed to reduce GHG emissions generated by fossil fuel-fired power plants. Maryland has participated in RGGI since 2007.[42] This "cap and invest" program has the exclusive purpose of supporting the development and implementation of each RGGI state's CO2 Budget Trading Program. RGGI oversees the auction of CO2 allowances.

The RGGI participating states conduct a comprehensive, period review of the program to consider program successes, impacts and potential changes to program design elements. In 2017, at the conclusion of the Second Program Review, the RGGI participating states reached a consensus on a series of improvements to the initiative:

1. Reduce the emission cap by an additional 30% from 2020 to 2030.
2. Add the innovative new Emissions Containment Reserve, which will reduce emissions even more when it is inexpensive to do so.
3. Adjust for the allowance bank remaining at the end of 2020.
4. Improve and maintain the Cost Containment Reserve, an important component to contain and cap compliance costs.

In October 2021, the RGGI participating states commenced a Third Program Review, which is expected to conclude in early 2023. Thereafter, states including Maryland will initiate their individual legislative and/or regulatory processes to implement program changes.

Following the quarterly auction of the allowances, the RGGI participating states invest their respective share of the auction proceeds in energy efficiency, renewable energy, and consumer benefit programs. Maryland's RGGI proceeds are deposited into the SEIF via a statutorily-established formula (e.g., at least 50% for energy assistance/low-income bill payment, at least 10% for energy efficiency directed at LMI Maryland residents, at least 10% for general energy efficiency, etc.). On balance, RGGI has seen net economic benefits among its member states.[43]

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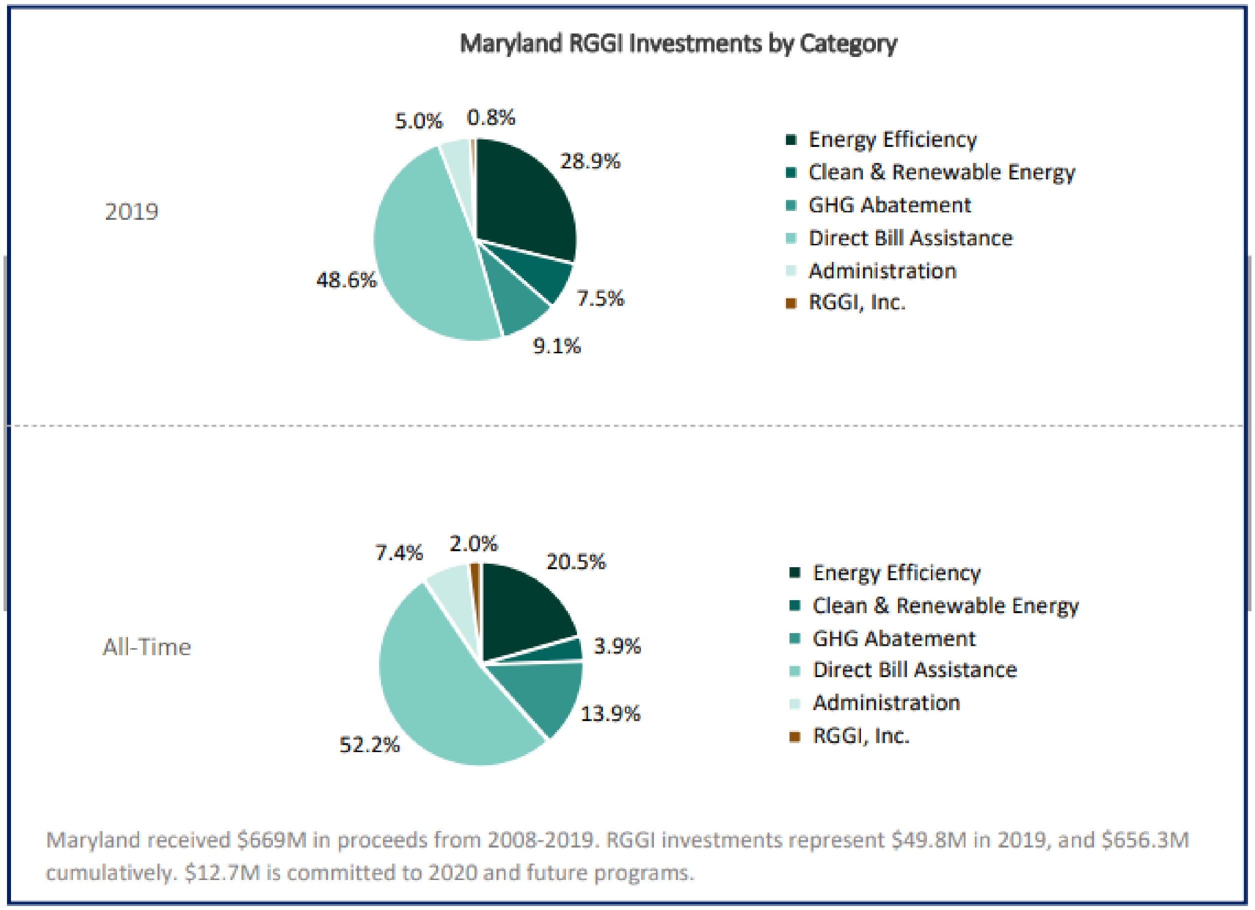
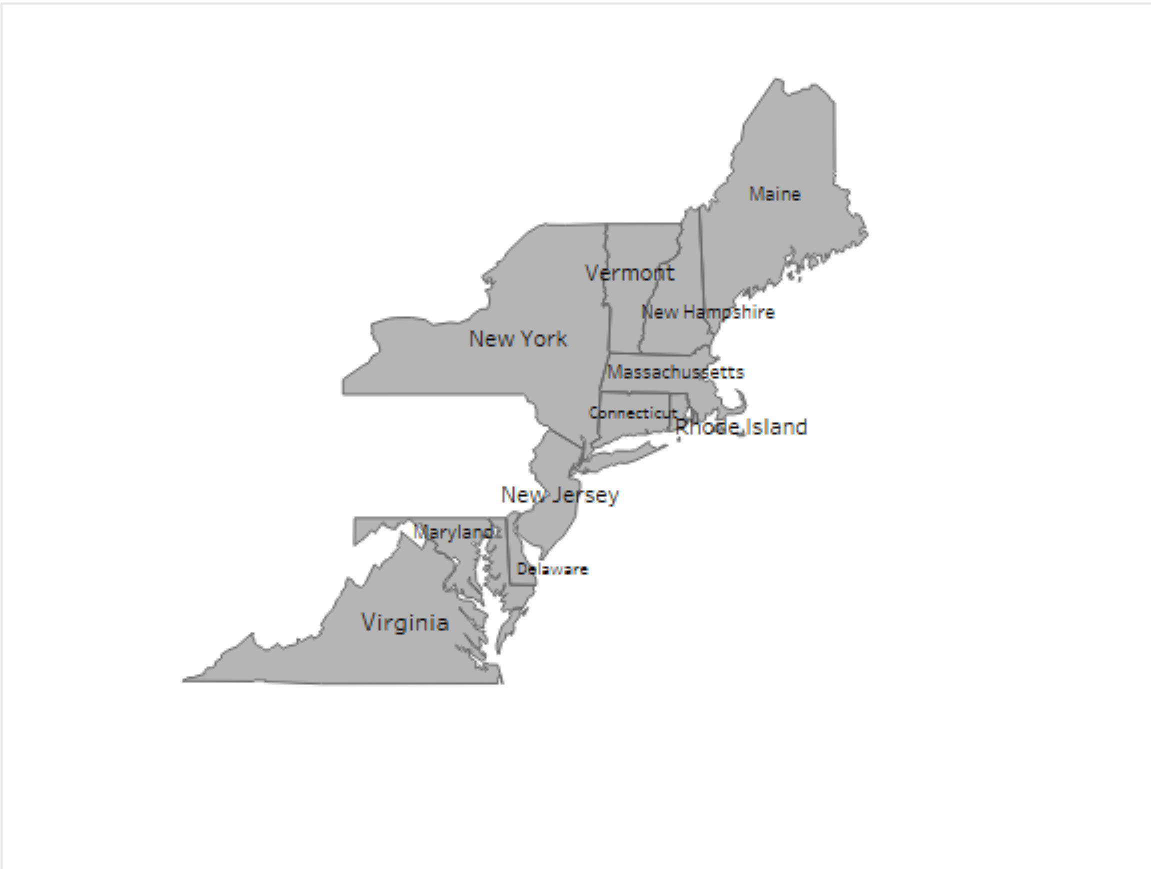
[42] For a primer, see this report from the Congressional Research Service: Congressional Research Service, The Regional Greenhouse Gas Initiative: Background, Impacts, and Selected Issues, updated July 2019, fas.org/sgp/crs/misc/R41836.pdf.

[43] Analysis Group, The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeast and Mid-Atlantic States, 2018, analysisgroup.com/globalassets/uploadedfiles/content/insights/publishing/analysis_group_rggi_report_april_2018.pdf.



Participation in RGGI has increased recently with the addition of New Jersey on Jan. 1, 2020 and Virginia on Jan. 1, 2021. While the additional states will create extra demand in the market, they also bring additional supply of allowances, making it difficult to determine pricing and revenue impacts.

RGGI Participating States



Source: RGGI, Elements of RGGI, rggi.org/program-overview-and-design/elements.

Energy Efficiency Statute:
Maryland has shown leadership in energy efficiency in the United States and ranked 6th on the ACEEE "State Energy Efficiency Scorecard" in 2020. The state passed the EmPOWER Maryland Energy Efficiency Act of 2008 that created a statewide goal of reducing electricity use and demand per capita by 15% below 2007 levels by 2015. During this period, consumers saved more than 5 million MWhs in electricity consumption and more than $4 billion in lifetime energy bill savings.[44] Utilities were required to ramp up electricity savings by 0.2% annually to reach 2% per year by 2020, starting from 2016. In 2017, the legislature passed a law codifying EmPOWER Maryland. As of the program year 2019, estimated savings exceeded 10 million MWh, valued at more than $10.5 billion.[45]

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[44] PSC, The EmPOWER Maryland Energy Efficiency Act
Report of 2016,
psc.state.md.us/wp-content/uploads/2016-EmPOWER-Maryland-Energy-Efficiency-Act-Standard-Report.pdf
[45] PSC, The EmPOWER Maryland Energy Efficiency Act

Strategic Energy Investment Fund (SEIF)

The Strategic Energy Investment Program aims to decrease energy demand and increase energy supply to promote affordable, reliable, and clean energy. MEA is the administrator of the SEIF. In addition, MEA implements SEIF-funded programs that support Maryland's energy-related policies and monitors SEIF-funded programs being implemented by other state agencies. The SEIF is funded primarily by proceeds from quarterly RGGI auctions,[46] along with any RPS-related ACPs that may accrue within a compliance year. ACP payments have been limited to date. In addition, the SEIF may receive income from other non-RGGI sources, such as settlement agreements with specific prescribed uses.

The SEIF funded over $70 million of energy-related programs and initiatives in FY20. More information on the SEIF can be found in the SEIF annual report.[47]

Emergency Management (Energy Assurance and Response Planning)

As the primary agencies for the State Coordinating Function (SCF), Energy, and Fuels, MEA and PSC are responsible for coordinating response and restoration strategies. The purpose of the Power Infrastructure SCF is to support and coordinate the state-level restoration of electric, gas, and commodity fuels and emergency delivery systems, in affected areas during times of an emergency. The objectives of the SCF-12 include:

- Provide liaison and communication between government agencies and the utility and emergency industries.
- Collect, evaluate, and share information on emergency system damage and estimations on the impact of emergency systems within affected areas.
- Facilitate restoration of emergency systems through legal authorities and waivers.
- Assist government and private sector stakeholders in overcoming challenges to restoring the emergency system.

PSC is responsible for acting as the state's liaison to electricity and natural gas services providers. In contrast, MEA's areas of responsibility are liquid petroleum fuels, including heating oil, propane, petroleum, and ethanol-based transportation fuels. PSC also must communicate to emergency management officials what plans utility companies have in place for restoring service. The strategy for restoration operations is based upon assessing the damage to a particular area's energy infrastructure in light of the public health hazards associated with compromised transmission lines, pipelines, or distribution equipment.

Report of 2019, psc.state.md.us/wp-content/uploads/2019-EmPOWER-Maryland-Energy-Efficiency-Act-Standard-Report.pdf.

[46] Regional Greenhouse Gas Initiative, Inc., Auction Results, rggi.org/auctions/auction-results.

[47] energy.maryland.gov/Reports/FY20%20SEIF%20Report%20Volume%201%20Final.pdf and energy.maryland.gov/Reports/FY20%20SEIF%20Report%20Volume%202%20Final.pdf.

In 2009, Maryland received American Recovery and Reinvestment Act funding from the U.S. Department of Energy (DOE) to enable the creation of an energy assurance plan. Three state agencies, MEA, Maryland Emergency Management Agency (MEMA, now MDEM), and the PSC, collaborated to develop the Maryland Energy Assurance Plan (EAP).[48] The broad purpose of the EAP is four-fold:

1. To provide an overview of Maryland's interdependent energy landscape as a means to enhance reliability and facilitate recovery from disruptions to the state's energy supply.
2. To provide background information that will help to guide investments in energy infrastructure going forward.
3. To provide an analysis of the pre-and post-emergency roles, responsibilities, and relationships between the various actors in the state's energy supply.
4. To provide background information to aid public agencies and private entities in developing specific procedural energy emergency plans.

These four purposes define the overarching goal of creating a more resilient energy infrastructure in Maryland that recovers quickly from disruption.

Emergency response plans usually assume critical infrastructure continuity, such as emergency control centers, hospitals, police, and fire services. These facilities should have an on-site backup power source to maintain continuity when the electric grid is down. Providing emergency power sources to these facilities is possible when the need for the resource can be predicted ahead of time (i.e., weather forecast). However, some emergencies may occur with little to no warning, such as a derecho, earthquake, or unexpected electrical blackout. In these cases, resiliency hubs (systems to provide location-flexible heating, cooling, and electronics charging capabilities in emergency situations) may be of value to provide short term (up to 5 days) of critical electric power to communities,[49] allowing a critical buffer until electric grid restoration, in addition to road clearing for citizen evacuation to operating emergency shelters. In 2018, MEA initiated a program to incentivize the development of resiliency hubs within LMI communities. MEA continues to work with local governments, MDEM, and other stakeholders to identify potential resiliency hub locations and how those hubs can be incorporated into local emergency management planning and response.

[48] 2012 Maryland Energy Assurance Plan, energy.maryland.gov/Documents/MarylandEnergyAssurancePlan.pdf.
[49] MEA, Resiliency Grant Hub Program, energy.maryland.gov/Pages/Resiliency-Hub.aspx.

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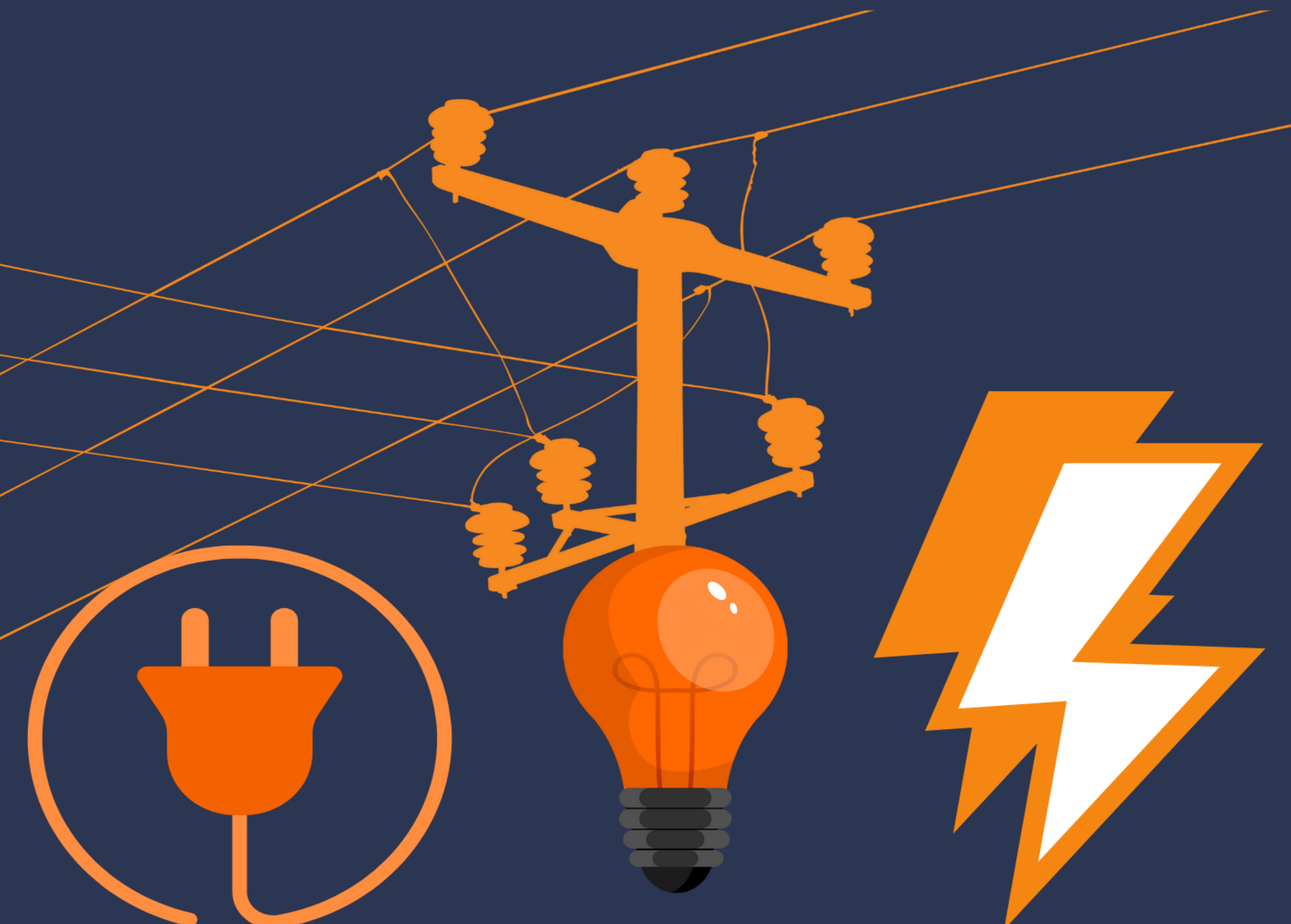

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Maryland Energy Administration

MAY 2022

Electricity

Introduction

The system delivering electricity to every Maryland household and business is a stunningly complex system joining policy, geography, and engineering. The energy residents use to power their homes comes from a disparate network of power plants and electric lines providing power to 65 million customers. This system must be nearly perfectly balanced between supply and demand at all times; and provide affordable, reliable energy whether conditions are a freezing night in the dead of winter or the middle of a scorching summer afternoon. Adding to the complexity, in Maryland, not all the energy consumed is generated in the state, which means there exists limited control over the entirety of the composition of electricity that supplies the state. In addition, it is necessary to have a reliable system, not just with low levels of power loss, but also the ability to meet consumer demands when the grid itself is most strained, usually in the summer months. The grid is old and aging, and broadly speaking, electricity reliability has decreased throughout the United States with a more than a 60% increase in "blackout events" nationwide.[50] Furthermore, some parts of the country have been unable to address these concerns adequately.[51] It is incumbent upon all stakeholders to maintain lower costs to consumers, provide cleaner generation, and provide access to a reliable source of energy. It is the tension between these three, sometimes mutually exclusive goals, that is the hallmark of the electricity system going forward. Understanding this system makes us all better energy consumers and helps us understand the changes the grid must undertake in the coming decades.

Generation

Maryland operates a deregulated electricity market where entities that generate electricity are separate from transmission and distribution entities. A power company intending to construct or modify a new generating station or high-voltage transmission lines must obtain a Certificate of Public Convenience and Necessity (CPCN) from the PSC. A CPCN constitutes state permission to construct or modify a power generation facility. This process includes written and oral testimony, cross-examination, and full public participation. It also involves the applicant, PPRP (which is part of DNR), PSC Staff, and the Office of People's Counsel (OPC) as well as any person granted intervenor status by the Commission. The status of generation projects that have applied for CPCNs as of August 2021 is shown in the Appendix.

Some of the notable generation facilities in Maryland are also listed in the Appendix. Most of the plants were built before the 21st century. The only nuclear plant in Maryland, Calvert Cliffs, came online in 1975, and has a capacity of 1,705 MW. Most of the coal and natural gas plants

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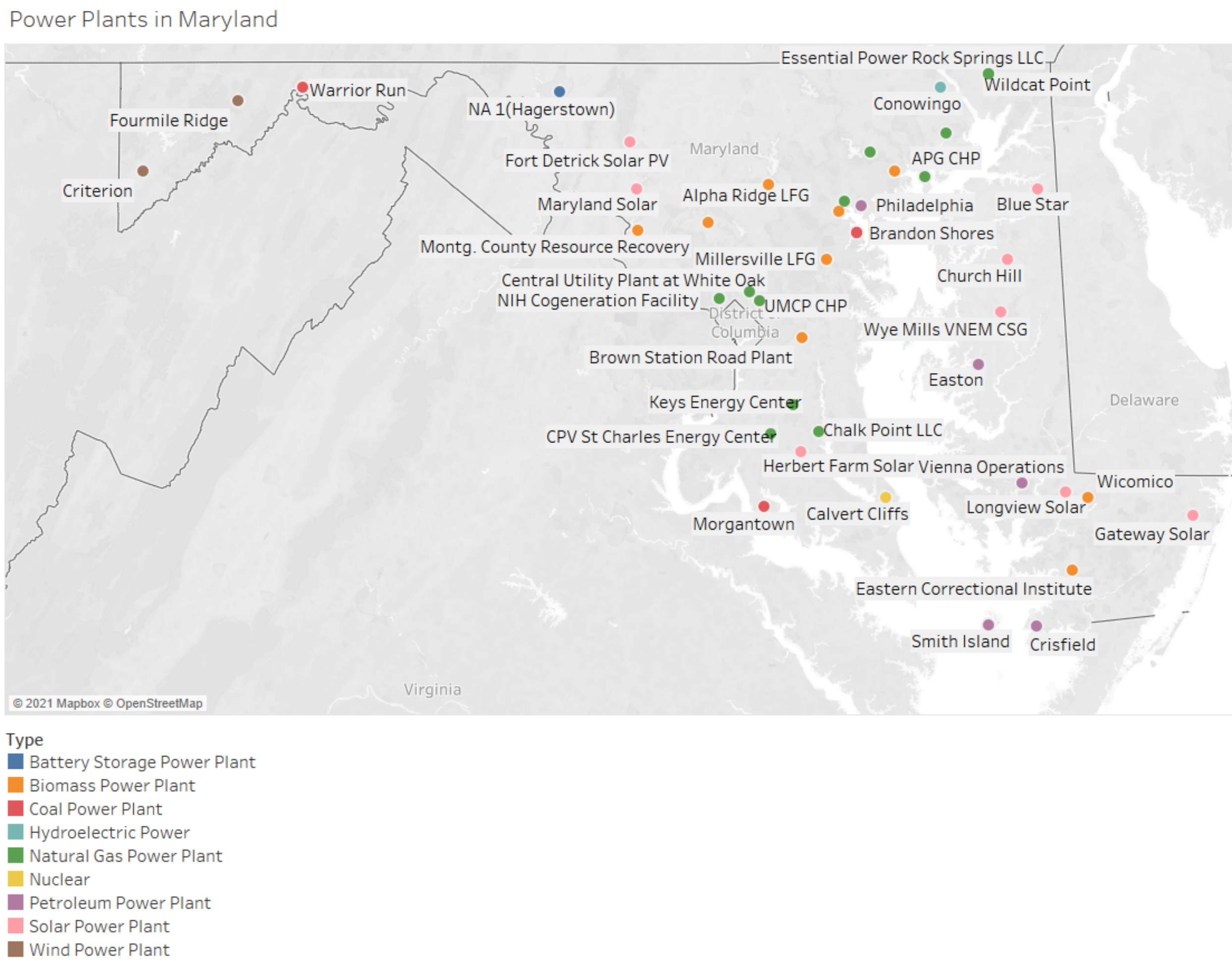
[50] Brian Stone Jr. et al., Compound Climate and Infrastructure Events: How Electrical Grid Failure Alters Heat Wave Risk, *Environmental Science and Technology*, 55, 2021, 6957-6964.
[51] National Electric Reliability Council, 2021 Summer Reliability Assessment, May 2021, nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC%20SRA%202021.pdf.

were online before 1980. One of the largest plants in Maryland is the Chalk Point Generating Station, with a capacity of 2,347 MW, and powered by coal and oil. In August 2020, the plant operator of the Chalk Point Generating Station, GenOn Energy Holdings, announced two coal-powered units' shut-down due in June 2021, right on the heels of their announcement that the coal units at Dickerson Generating Station would also be closing.[52] GenOn then announced on June 9, 2021, the anticipated retirement of the 1,229 MW Morgantown Generating Station coal units as of June 1, 2022.[53]

Power Plants Currently Operating in Maryland



Source: (Map Developed by MEA).

[52] GenOn, GenOn Holdings, Inc. Announces Retirement of Chalk Point Coal Units, genon.com/genon-news/genon-holdings-inc-announces-retirement-of-chalk-point-coal-units; GenOn, GenOn Holdings, Inc. Announces Retirement of Dickerson Coal Plant, genon.com/genon-news/genon-holdings-inc-announces-retirement-of-dickerson-coal-plant.
[53] GenOn Holdings, LLC Announces Retirement of Three Coal-Fired Power Plants, https://www.genon.com/genon-news/genon-holdings-llc-announces-retirement-of-three-coal-fired-power-plants.

Natural Gas

Natural gas is rapidly displacing coal and petroleum generation throughout Maryland, and is part of a larger national and international trend that has contributed, and continues to contribute, to carbon reductions.[54] Natural gas carbon emissions per unit of energy are roughly half that of coal or petroleum-fired plants, significantly reducing carbon emissions in the power sector. CO2 emissions reductions are only one benefit from natural gas generation. Another critical role is utilizing this form of reliable generation for load-balancing services, especially as the grid increasingly demands higher levels of flexibility. In particular, natural gas supports the ongoing energy transition by facilitating the integration of clean intermittent resources on the grid.[55] Reliable load-balancing generation is necessary for the electrical grid to function, and the more flexible-ramping capabilities of natural gas generation fills this role.[56] Finally, the current natural gas distribution infrastructure may have the capability to eventually be used to distribute renewable gaseous fuel,including biogases and green, blue, and gray hydrogen, throughout the state, mitigating the long-term concerns regarding contracting and stranded assets.[57] Natural gas is a reliable, mature system that can be installed and expanded with relative ease compared to other generation sources, which have increased costs and risks that cannot meet the scalability and reliability profiles the existing systems require.

As a final point, given the announced retirements of most of the coal fleet in Maryland, maintaining this stable generation in-state becomes a more prominent and urgent issue. It should also be noted that a significant portion of the natural gas fleet in Maryland is relatively old, and retirements could cause grid issues over the medium to long term.[58]

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[54] Stanford University, "U.S. energy technology and policy needs an all-of-the-above approach, experts say," energy.stanford.edu/news/us-energy-technology-and-policy-needs-all-above-approach-experts-say; International Energy Agency, World Energy Outlook Special Report: The Role of Gas in Today's Energy Transitions, 2019, iea.org/reports/the-role-of-gas-in-todays-energy-transitions.

[55] United Nations Economic Commission for Europe, *How Natural Gas Can Support the Uptake of Renewable Energy*, ECE Energy Series No. 66 (2019); National Bureau of Economic Research, Elena Verdolini, Francesco Vona & David Popp, Bridging the Gap: Do Fast Reacting Fossil Technologies Facilitate Renewable Energy Diffusion?, NBER Working Paper 22454 (2016) nber.org/papers/w22454 .

[56] Joint report by IHS Markit (with involvement by Daniel Yergin, PhD) and Energy Futures Initiative (with involvement by Ernest Moniz, former Secretary of Energy in the Obama Administration) Advancing the Landscape of Clean Energy Innovation (2019), 25, static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5e56b4e66212a045e9892505/1582740734147/Advancing+the+Landscape+of+Clean+Energy+Innovation.2+2019.pdf .

[57] Michael A. Mac Kinnon, Jacob Brouwer, Scott Samuelsen, "The role of natural gas and its infrastructure in mitigating GHG emissions, improving regional air quality, and renewable resource integration," *Progress in Energy and Combustion Science*, 64 (2018) 62-92; United Nations Economic Commission for Europe, *Pathways to Sustainable Energy Accelerating Energy Transition in the UNECE Region*, ECE Energy Series No. 67 (2020) 30-32; Department of Energy, Hydrogen Pipelines, energy.gov/eere/fuelcells/hydrogen-pipelines#:~:text=Gaseous%20hydrogen%20can%20be%20transported,operating%20in%20the%20United%20States.&text=Transporting%20gaseous%20hydrogen%20via%20existing,delivering%20large%20volumes%20of%20hydrogen.

[58] Age of plants from EIA-860 data. The trend for combined cycle plants retiring after roughly 30 years seems to be more the norm, as opposed to the roughly 50 year retirements from single cycle plants: S&P

It is also worth reproducing a quote from a recent research paper from Columbia University's Center on Global Energy Policy describing the benefits of utilizing gas infrastructure within the framework of a lower-cost transition to a cleaner energy system:

> However, investments in pipeline infrastructure have drawn concern that they would lock fossil fuels into the US energy mix for a longer period of time and work against the energy transition. Such concerns are understandable given the contribution of fossil fuels to the global climate crisis. But retrofitting and otherwise improving the existing pipeline system are not a choice between natural gas and electrification or between fossil fuels and zero-carbon fuels. Rather, these investments in existing infrastructure can support a pathway toward wider storage and delivery of cleaner and increasingly low-carbon gases while lowering the overall cost of the transition and ensuring reliability across the energy system. In the same way that the electric grid allows for increasingly low-carbon electrons to be transported, the natural gas grid should be viewed as a way to enable increasingly low-carbon molecules to be transported.[59]

Natural gas networks should be harnessed to assist in a clean energy transition. Plotting a clean path for that network can both provide low-cost resilience while meeting climate goals.

Natural gas generation is also used in highly efficient and resilient on-site combined heat and power (CHP) systems (also known as cogeneration systems). It can effectively and reliably generate useful heat and electric power using less fuel than a typical system that only generates power.[60] CHP systems offer customers on-site distributed power with predictable and consistent heat and power needs (particularly large commercial, industrial, and institutional facilities), providing significant economic savings and reductions in fuel consumption and GHG emissions. CHP can also be used in applications that have significant and coincident power and thermal loads. For optimal cost-effectiveness, CHP systems are typically designed and sized to meet a facility's year-round baseload thermal demand, which can include steam, hot water, chilled water, process heat, refrigeration, and dehumidification and can generate electricity and use

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Global Market Intelligence, Average age of US power plant fleet flat for 4th-straight year in 2018, spglobal.com/marketintelligence/en/news-insights/trending/gfjqeFt8GTPYNK4WX57z9g2#:~:text=16%20Jan%2C%202019-,Average%20age%20of%20US%20power%20plant%20fleet,4th%2Dstraight%20year%20in%202018&text=The%20capacity%2Dweighted%20average%20age,fourth%20year%20in%20a%20row; Ibid., Nearly 8,500 MW of gas capacity retirements in store for US through 2026, spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/nearly-8-500-mw-of-gas-capacity-retirements-in-store-for-us-through-2026-57365717.

[59] Erin M. Blanton et al., Investing in the US Natural Gas Pipeline System to Support Net-Zero Targets, Center on Global Energy Policy, Columbia University School of International and Public Affairs, 6, energypolicy.columbia.edu/research/report/investing-us-natural-gas-pipeline-system-support-net-zero-targets?utm_source=Center+on+Global+Energy+Policy+Mailing+List&utm_campaign=38d4ab05a7-EMAIL_CAMPAIGN_2019_09_24_06_19_COPY_01&utm_medium=email&utm_term=0_0773077aac-38d4ab05a7-102262861.

[60] Environmental Protection Agency, Combined Heat and Power (CHP) Partnership: CHP Benefits, epa.gov/chp/chp-benefits.

waste heat to meet some, or all, of these demands. These systems can be installed in many different facilities, including: commercial buildings, hotels and casinos, airports, college and university campuses, large office buildings, nursing homes, hospitals, correctional facilities, military bases, and in-district energy systems. The main benefits of CHP are reduced energy costs due to its high efficiency (70-80% for common generation types compared to the average of 33-50% with more conventional generation) and increased energy reliability.[61] CHP can also provide lower energy costs by replacing higher priced purchased electricity and boiler fuel with lower-cost self-generated electricity and recovered thermal energy. The impacts are significant; for example, the 6 MW CHP system installed at the Gaylord National Resort and Convention Center is able to meet roughly 90% of facility electricity demand in a given year.[62]

Maryland has very few economically viable gas reserves. Maryland produced just 10 million cubic feet of natural gas in 2019, most of which was produced in the western part of the state.[63] In 2017, Maryland became the third state after New York and Vermont to enact a permanent ban on hydraulic fracturing for natural gas production. Demand for natural gas in the state is largely met by several interstate pipelines. One major source of demand for natural gas in Maryland is the Cove Point Liquefied Natural Gas (LNG) marine export terminal, which shipped 227.5 billion cubic feet (Bcf) of LNG abroad in 2019.[64] Pipelines transport natural gas from the Gulf Coast and Southwest as well as from Pennsylvania. About a third of the natural gas that passes through Maryland is consumed in-state (roughly 298 Bcf was consumed in-state in 2019),[65] while the rest is either in transit to other states or exported abroad. The electric power sector is currently the highest natural gas-consuming sector in Maryland, accounting for about 33% of natural gas end-use in 2019. Residential and commercial applications made up over 50% of natural gas applications. Industrial and transportation accounted for the rest of natural gas applications.

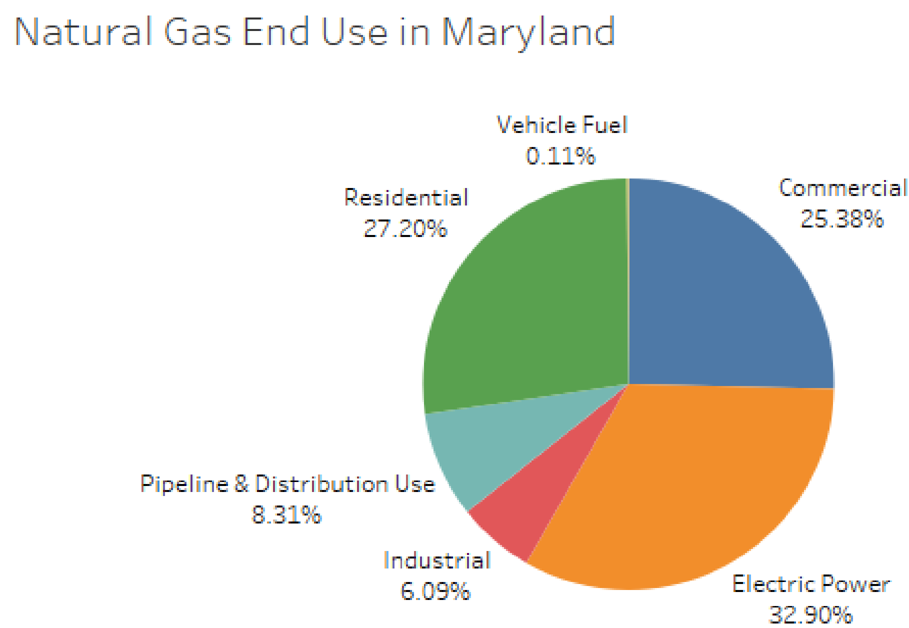
[61] US Environmental Protection Agency, epa.gov/chp/chp-benefits#:~:text=By%20using%20waste%20heat%20recovery,an%20on%2Dsite%20boiler).

[62] Gaylord National Resort, Press Release, nationalharbor.com/press-releases/s-o-a-p-opens-bath-and-body-boutique-at-national-harbor/.

[63] Energy Information Administration, Natural Gas Gross Withdrawals and Production, 2019, accessed January 2021, eia.gov/dnav/ng/NG_PROD_SUM_A_EPG0_VGM_MMCF_A.htm.

[64] Energy Information Administration, U.S. Natural Gas Exports and Re-Exports by Point of Exit, eia.gov/dnav/ng/ng_move_poe2_dcu_YCPT-Z00_a.htm.

[65] Ibid., Profile Data, eia.gov/state/data.php?sid=MD#ConsumptionExpenditures.



Source: Using data derived from the Energy Information Administration.

Many Marylanders still do not have access to natural gas and often rely on commodities with a larger emissions footprint. Displacing these higher emitting generation types with natural gas is economically and environmentally beneficial. Even though natural gas is a fossil fuel, emissions from its combustion are approximately 50% less than coal or oil. It also has lower NOx, SOx, and particulate emissions than coal or liquid petroleum fuels. A key difficulty with conversions from higher emission sources to gas distribution expansion is the inadequate cost recovery period. Infrastructure investment of this type typically requires some guaranteed revenues to pay for the fixed capital costs of the actual expansion - often, this is not easy to attain. If a prospective line extension cannot pay for itself within a given period, the end-user may be required to pay the difference. The result is that the end-user, especially those in more rural areas such as the Eastern Shore, chooses the short-term, least-cost, higher emission option, typically propane or fuel oil. These fuels are more expensive than natural gas, and they increase GHG emissions.

In 2018, the PSC approved the WGL Holdings (WGL) merger with AltaGas Ltd. The $9 billion merger brought together two complementary energy companies positioned for the potential strategic application of new energy infrastructure across the state. Through the merger, WGL was ordered to provide the following direct benefits to the state:

- $30.5 million and a one-time $50 rate credit for Maryland residential heating customers and a rate credit for non-residential customers. The companies committed that operational savings resulting from the merger will be passed through to customers.
- $22.8 million to Montgomery and Prince George's counties for workforce development and energy efficiency programs with at least 20% of such funds directed to benefit LMI residents in both single and multifamily communities.

- $100 million to expand natural gas infrastructure in the state, which includes $70 million over 10 years in the Washington Gas service area, and $30.32 million to promote economic development, job creation, and the expansion of natural gas infrastructure to underserved parts of Maryland.
- The merger also included an additional $4 million to enhance infrastructure safety further.

It is part of this settlement that is being utilized to bring natural gas infrastructure to the Eastern Shore, including providing the Eastern Correctional Institution (ECI) and the University of Maryland Eastern Shore (UMES) campus with access to natural gas, replacing wood chips and heating oil,respectively, as their principle energy sources.

Petroleum

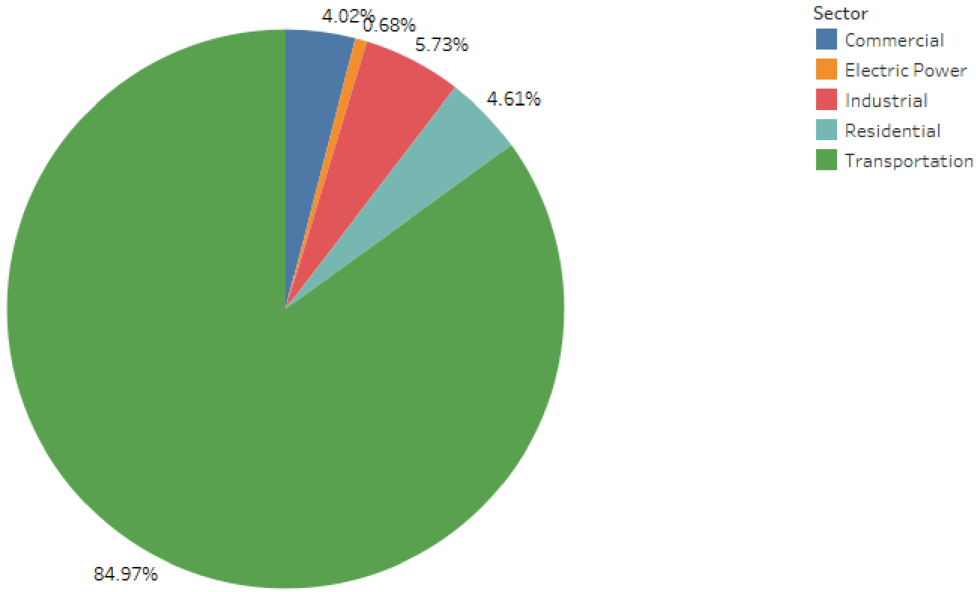
Maryland has no viable petroleum reserves, and there is a ban in place on hydraulic fracturing signed into law by Governor Hogan in 2017. Most petroleum products, including gasoline and diesel fuel, used in Maryland are delivered via pipeline. And, while there are no petroleum refining operations in Maryland, refined petroleum products are still delivered through a Colonial Pipeline system.[66] Refined petroleum products are also delivered through the Baltimore deep-water port and via rail.[67]

In 2018, Maryland had the third-lowest petroleum consumption per capita in America, with only New York and the District of Columbia having lower petroleum consumption per capita.[68] Also, about 85% of petroleum products were used for transportation. Industrial applications account for 6% of petroleum product use. Residential and commercial applications each account for 4% of petroleum product end-use. Electricity generation accounts for just 1% of use.[69]

Petroleum End Uses

[66] Energy Information Administration, Maryland: Profile Analysis, eia.gov/state/analysis.php?sid=MD#20.
[67] Tri Gas and Oil, New Propane Terminal Now Complete in Baltimore for Mid-Atlantic Rail Services, a Tri Gas & Oil affiliate, trigas-oil.com/news/press-releases/new-propane-terminal-now-complete-baltimore-mid-atlantic-rail-services-tri-gas-oil-affiliate/.
[68] Energy Information Administration, State Energy Data System, Table C15, Petroleum Consumption, Total and per Capita, Ranked by State, 2018.
[69] Ibid., State Energy Data System, Table F16, Total Petroleum Consumption Estimates, eia.gov/state/seds/data.php?incfile=/state/seds/sep_fuel/html/fuel_use_pa.html&sid=US, 2018.

Petroleum End Uses



Source: Using data derived from the Energy Information Administration.

Coal

Maryland's coal resources are located in the state's Appalachian basin. The state produced 0.2% of total coal production in the U.S. in 2019, most of which were extracted from surface coal mines. There are 12 coal mines in Maryland, 11 are surface mines, and one is an underground mine.[70] Most of the coal used in Maryland is for electric power generation. However, as of the end of 2020, most of Maryland's coal power generation plants have indicated operations in the state were untenable. This is part of a larger decline in the industry, due primarily to market forces making coal generation unprofitable.

In recent years, the overwhelming, primary reason for coal plant closures has been the resurgence of low-cost, low-carbon natural gas production in the United States. Perhaps one of the best studies that outline this reasoning is seen in a joint Rhodium Group-Columbia University report from April 2017.[71] The research clearly shows the poor economics of the coal industry going forward. This is a robust trend that is expected to continue. However, it should be noted that there may be an increase in coal production and generation in 2021 and 2022 as the market regularizes from COVID-related adjustments and responds to an expected increase in

[70] U.S. EIA, Annual Coal Report 2019 (October 5, 2020), Table 1, Coal Production and Number of Mines by State and Mine Type, 2019 and 2018.
[71] Trevor Houser, Jason Bordoff, Peter Masters, Can Coal Make a Comeback? April 2017. Center on Global Energy Policy, Columbia University, energypolicy.columbia.edu/sites/default/files/Center%20on%20Global%20Energy%20Policy%20Can%20Coal%20Make%20a%20Comeback%20April%202017.pdf.

natural gas prices. The EIA projects that coal's share of electricity generation in the United States will increase in 2021 due to increased natural gas prices. It is expected that coal generation will rise from 20% in 2020 to 22% in 2021, and 23% in 2022.[72]

All but one of Maryland's coal plants have announced plans to cease generating electricity from coal and either shut down permanently or convert to other energy sources. For instance, Talen Energy announced in November 2020 that their remaining coal facilities at Brandon Shores and Wagner would shut down coal operations and refuel by 2025.[73] Warrior Run (owned by AES Corporation), a relatively small 229 MW plant located in western Maryland and the only remaining coal generation asset without a retirement date, is under a Public Utility Regulatory Policies Act (PURPA) contract[74] guaranteeing payments through 2030.

Nuclear

Nuclear energy has a long history of providing emission-free, safe, reliable, and scalable power worldwide, including to Maryland's electric grid. Nuclear power has the highest capacity factor[75] of any generation type with lower emissions than any competing source.[76] Maryland's only nuclear power station, Calvert Cliffs, began operation in 1975, and consists of two pressurized water reactors with nameplate generation capacities totaling 1,718 MW. Calvert Cliffs has never had a serious safety incident or accident; indeed, it has one of the best overall safety records of the entire U.S. commercial nuclear reactor fleet. In 2019, Calvert Cliffs accounted for 38% of net electricity generation in Maryland and about 80% of the zero-emission electricity generated in Maryland, ahead of the next closest zero-emission power station in Maryland, the Conowingo Dam.

The higher capacity factor is indicative of a highly reliable generating asset, given Calvert Cliffs near continual operation with low downtime, producing baseload electricity for Maryland and the broader PJM network. Calvert Cliffs' capacity factor is typically over 90%, which means the full 1718 MW of power is available at nearly all times, and unlike many other nuclear generating stations in the United States, Calvert Cliffs remains profitable. The operating licenses for Calvert Cliffs Unit 1 and Unit 2 expire in 2034 and 2036, respectively, and it is unclear at this point if Exelon (the owner of Calvert Cliffs) will pursue a renewal. Due to the fact that many thousands of megawatts of baseload coal generation assets are set to retire, Maryland must consider the

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[72] EIA, Short-Term Energy Outlook: Electricity, Forecast release date April 6, 2021, eia.gov/outlooks/steo/report/electricity.php.
[73] Talen Energy, Talen to exit coal, invest in renewable energy and storage, November 10, 2020, spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/talen-to-exit-coal-invest-in-renewable-energy-and-storage-61217970.
[74] The Public Utility Regulatory Policies Act was enacted in 1978 to further energy conservation and diversification in the wake of the oil crises. See: FERC, PURPA Qualifying Facilities, ferc.gov/qf.
[75] Capacity factor is the ratio of actual electrical energy output and the maximum electrical energy output over a period of time from a generating unit.
[76] Charles McCombie and Michael Jefferson, Renewable and nuclear electricity: Comparison of environmental impacts, *Energy Policy* 96 (2016) 758–769.

siting and development of next-generation,[77] emissions-free, nuclear-generating assets to replace the lost generation capacity at sites such as, but not limited to, Calvert Cliffs. These reactors may be larger, Generation III+ reactors, or may be Small Modular Reactors (SMRs) that are classified as Generation III+ and Generation IV reactors.

There is further discussion regarding advanced nuclear power in the Clean Energy and Resilience section.

Renewables

Renewable energy generation (both utility and small scale) made up approximately 12% of net generation in Maryland in 2019, with hydroelectric power generation accounting for almost half of all renewable energy generation.[78] Conowingo hydroelectric plant is the largest renewable electricity plant in the state, with a generating capacity of about 530 MW.[79] It also has "black start" capability, which is the ability to restart the power grid after a widespread outage.

Solar generation makes up about one-third of the state's renewable energy generation; two-thirds of that generation comes from non-industrial-scale solar photovoltaics. As of February 2021, total installed solar capacity across utility, residential, and commercial systems was about 1,393 MW,[80] with nearly 165 MW installed in 2019 alone.[81] Just over 4% of total electricity net generation in the state comes from solar systems.

One of the larger solar photovoltaic (PV) installations in Maryland is the 18.6 MW-dc (approximately 15 MW-ac) system at the Fort Detrick Army Base, which supplies about 12% of the annual site load.[82] Another notable installation is the Longview Solar farm in Worcester County, which provides approximately 13 MW.

Many solar PV projects of varying capacities, some of them over 20 MW, are presently under development and the technology still holds high-installation potential across the state. While residential solar installations remain a significant portion of the Maryland solar market share, the latter half of the 2010s saw a notable uptick in utility-scale installations.[83] The Solar Energy

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[77] Generation IV Reactors are currently being designed to offer significant advances in sustainability, economics, and safety.
[78] EIA, Electricity Data Browser, Maryland, Net generation for all sectors (thousand megawatt hours), annual, 2001-19.
[79] Ibid., Form EIA-860 survey data.
[80] PJM Environmental Information Service (EIS), Generation Attribute Tracking System, Renewable Generators Registered in GATS, gats.pjm-eis.com/gats2/PublicReports/RenewableGeneratorsRegisteredinGATS.
[81] Ibid.
[82] Amaresco and U.S. Army Celebrate Completion of Large-Scale 18 MW-DC Solar Energy Project at Fort Detrick, ameresco.com/ameresco-u-s-army-celebrate-completion-large-scale-18-mw-dc-solar-energy-project-fort-detrick/
[83] State Solar Spotlight (Q3 2020), Maryland, SEIA, seia.org/sites/default/files/2020-12/Maryland.pdf

Industries Association (SEIA) also projects that over 1,300 MW of additional solar installations will occur within the next five years in Maryland, where the industry continues to grow and progress, with over $3.4 million invested in solar PV technology and industry prices falling roughly 45% from 2015 to 2020.[84]

In Maryland, wind generation currently makes up a small portion of total electricity generation, coming mainly from onshore wind located in the western mountains. Roughly 190 MW of wind capacity is currently installed in the Appalachian mountains of Maryland, which have the most favorable geographic conditions for wind generation. Most of the rest of the state has less ideal conditions for onshore wind.[85] The only onshore wind project under development is the 70 MW Dan's Mountain project in Allegany County, which is expected to reach commercial operation in 2023.

Maryland does, however, have excellent offshore wind potential making it Maryland's largest renewable energy resource. Two offshore wind projects are currently under development, and each will be constructed over two phases. The projects are located in two federal lease areas off the coast of Maryland and Delaware where the closest project will be constructed approximately 15 miles off the state's coast and the other at 20 miles. The projects are expected to reach commercial operation in 2026 and will consist of a combined 2022.5 MW of capacity. The projects are expected to generate about 7 million MWh annually and power nearly 600,000 average Maryland homes. These projects will result in significant economic development and job creation in Maryland.

Biomass makes up about 8% of renewable energy generation in Maryland.[86] Two biomass electricity plants account for most biomass capacity: the Wheelabrator Incinerator in Baltimore (~57 MW) and the Montgomery County Resource Recovery Biomass Facility (~54 MW). These facilities convert municipal solid waste into electricity, and the Wheelabrator plant also produces municipal steam that provides heating energy to more than 250 businesses in Baltimore.[87] Additionally, there are biomass facilities under various stages of development and installation across the state. Some of these facilities will produce pipeline-grade renewable natural gas (RNG) from animal and food waste for injection into the Maryland distribution pipeline system for use in power generation stations and vehicle fleets pursuing alternative and renewable fuel sources.

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[84] Maryland Solar, SEIA, seia.org/state-solar-policy/maryland-solar.

[85] Department of Energy, WINDExchange, Wind Energy in Maryland, windexchange.energy.gov/states/md.

[86] U.S. EIA, Electricity Data Browser, Maryland, Net generation for all sectors (thousand megawatt hours), annual, 2019, eia.gov/electricity/data/browser/#/topic/0?agg=2,0,1&fuel=vtvv&geo=00000008&sec=g&freq=A&start=2001&end=2019&ctype=linechart&ltype=pin&rtype=s&pin=&rse=0&maptype=0.

[87] Maryland State Profile and Energy Estimates, U.S. EIA, eia.gov/state/analysis.php?sid=MD.

Carbon Capture Utilization and Storage (CCUS)[88]

Carbon Capture Utilization and Storage (CCUS) is the process of capturing CO_2 formed during industrial processes and power generation, compressing it for transportation, and either permanently sequestering it in geological formations, or binding it in final products for use.

In a 2018 document, the Intergovernmental Panel on Climate Change (IPCC) produced a report indicating that governments cannot meet aggressive climate targets without utilizing carbon capture technologies. Three out of the four IPCC modeling scenarios, developed to determine optimal scenarios for GHG reductions, necessitated the use of carbon capture technologies.[89] Negative emissions technologies, such as CCUS, have historically been underfunded as a carbon emissions mitigation strategy and may deserve more support as part of a flexible carbon management system.[90]

There has been a recent increase in funding in the U.S. and abroad, with increases in the U.S. typically coming in the form of tax credits and Europe providing increases in the form of direct financial support. Most recently, Norway, long a leader in combating climate change, just approved billions in government support for two major carbon capture projects, "Longship" and "Northern Lights."[91] Additional support to develop economies of scale is still needed, but reaching net-zero emissions in the necessary timeframe will be next to impossible without using carbon capture technologies.[92] This trend and understanding is growing in the policy community,[93] and in 2019 MEA hosted the "Future of Carbon Capture Conference" to begin

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[88] For a good primer on permanently sequestered carbon: National Academies of Science National Academies of Sciences, Engineering, and Medicine. 2018. Geologic Capture and Sequestration of Carbon: Proceedings of a Workshop–in Brief. Washington, DC: The National Academies Press. nap.edu/catalog/25210/geologic-capture-and-sequestration-of-carbon-proceedings-of-a-workshop. For Maryland specific, MEA held a workshop in November 2019: Maryland Energy Administration, The Future of Carbon Capture in Maryland, news.maryland.gov/mea/2019/12/13/the-future-of-carbon-capture-in-maryland-conference-review/. For a more in-depth look: National Academies of Sciences, Engineering, and Medicine. 2019. *Negative Emissions Technologies and Reliable Sequestration: A Research Agenda*. Washington, DC: The National Academies Press. nap.edu/catalog/25259/negative-emissions-technologies-and-reliable-sequestration-a-research-agenda.

[89] IPCC Special Report, Global Warming of 1.5 degrees celsius, ipcc.ch/sr15/.

[90] Bipartisan Policy Center and EFI, Carbon Removal: Comparing Historical Federal Research Investments with the National Academies' Recommended Future Funding Levels, 2019, static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5cd5968abab2200001c68cc5/1557501586386/Carbon-Removal-Comparing-Historical-Investments-with-the-National-Academies-Recommendations.pdf.

[91] Government of Norway, Ministry of Petroleum and Energy, regjeringen.no/en/aktuelt/funding-for-longship-and-northern-lights-approved/id2791729/.

[92] International Energy Agency, CCUS in Clean Energy Transitions, 2020, iea.org/reports/ccus-in-clean-energy-transitions.

[93] EFI and Stanford, An Action Plan for Carbon Capture and Storage in California: Opportunities, Challenges, and Solutions, Summary for Policymakers, static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5fda37fbad9c280a18a46304/1608136703124/EFI-Stanford-CA-CCS-SFPM-rev2-12.11.20.pdf.

conversations for carbon capture in Maryland. Presentations and [videos](#) can be found on the MEA [website](#).

There are currently 10 large operating CCS[94] facilities and some smaller-scale CCS operations in the United States. None of the facilities are located in Maryland, but in-state potential deployment exists for both capture and storage. Importantly, CCS allows existing industries dependent on fossil fuels to continue operating (while not emitting carbon into the atmosphere), preventing job losses that could otherwise occur from the loss of industries or the shutdown of plants and other facilities. One of the least acknowledged benefits for carbon capture is the ability to augment heavily emitting industrial facilities to capture and permanently sequester CO_2. This benefit will be important for certain industries, such as the cement industry, that are vital to society yet emit high levels of CO_2. The ability to impact both the power sector and heavily-emitting industrial facilities is vitally important and unique to this technology. CCS facilities provide strong economic benefits and well-paying jobs through the planning, construction, operations, and maintenance phases.[95] This employment-related support extends through industrial facilities and associated supply chains. Furthermore, these technologies are pragmatic, with increased deployment in the U.S. and overseas.[96] And, while there remains some concern regarding CO_2 leakage, the evaluation and modification tools (e.g., proper siting, review, modification, and monitoring) have made great strides in significantly reducing this risk.[97]

Companies that are able to utilize CO_2 have also begun introducing products in the marketplace. The concrete industry has made the most progress, manufacturing materials that can convert CO_2 to a mineral in the concrete-making process, permanently sequestering it as a solid.[98] This is especially useful given the relatively facile ability to augment cement facilities with carbon capture technology, which makes capture conveniently located near utilization points. Finally, direct air capture (DAC) technologies will also be crucial to mitigating existing CO_2-related environmental damage by removing already released CO_2 from the atmosphere.[99] Negative emissions technologies like DAC and bioenergy with carbon capture and storage (BECCS), which

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[94] CCUS is an umbrella term but most projects currently operating are carbon capture and storage operations, i.e., capturing the CO_2 and sequestering in appropriate geologic formations.
[95] Rhodium Group, The Economic Benefits of Carbon Capture: Investment and Employment Estimates for the Contiguous United States, rhg.com/research/state-ccs/?mc_cid=e8e5e49092&mc_eid=384125dc33.
[96] For a good overview of global projects: Global CCS Institute, Global Status of CCS 2020, globalccsinstitute.com/resources/global-status-report/.
[97] See Chapter 7 p 320: National Academies of Sciences, Engineering, and Medicine. 2019. *Negative Emissions Technologies and Reliable Sequestration: A Research Agenda*. Washington, DC: The National Academies Press. doi.org/10.17226/25259; Alcalde, J., Flude, S., Wilkinson, M. et al. Estimating geological CO_2 storage security to deliver on climate mitigation. Nat Commun 9, 2201 (2018). doi.org/10.1038/s41467-018-04423-1.
[98] For a good example of this, see: CarbonCure: The Technology, carboncure.com/technology/; CO2Concrete, co2concrete.com/.
[99] See specifically Chapter 5: National Academies of Sciences, Engineering, and Medicine. 2019. *Negative Emissions Technologies and Reliable Sequestration: A Research Agenda*. Washington, DC: The National Academies Press. doi.org/10.17226/25259. nap.edu/read/25259/chapter/7.

convert biomass to energy and store the CO_2 released through the production process, are critical to meeting long-term climate goals. Many companies with these technologies are also looking to scale up and reduce costs.[100] It should also be noted that some federal support already exists for carbon storage projects in the form of 45Q tax credits.[101] The support ranges from $35 to $50 per metric ton of CO_2, based on project type (and based on tons of CO_2 sequestered), with the highest ($50 amount) reserved for non-enhanced oil recovery, permanent sequestration projects.

The Transmission and Distribution of Electricity

The electricity industry has experienced significant changes since the 1990s. Among those changes are electric choice (bringing a diversity of supplier choices to energy consumers), and the increased adoption of DERs, which bring residences and commercial facilities more directly into the energy mix. Market participants have also increased efforts to reduce the harmful effects of carbon-emitting electricity generation through various policy means, such as establishing RPSs, and the concomitant increase in clean and renewable energy generation. However, this effort has all taken place on transmission and distribution grids that have remained virtually unchanged, in their core design and purpose, for over a century, and built for single source generation as close in proximity to load centers as possible. That means the grid will need to undergo heavy modifications beyond the patchwork upgrades and replacements the system has already received. These patchwork upgrades and replacements of existing equipment have already created a net increase in costs, and a reworking of the grid for updated applications will most likely require far greater investments. Grid implementation costs have lowered slightly due to technological advancements, but have not outpaced increased demand. As the state moves toward increased electrification, these costs are sure to grow.

To keep up with the energy market's capabilities and changing needs, spending on energy infrastructure will increase, potentially increasing ratepayers' costs. Historically, investment in electricity infrastructure has utilized a regulatory approach that ensures sufficient spending to meet a baseline level of service, keeping ratepayer costs down. The investment strategy coincided with the expected long useful life of installed assets and has characterized the energy industry for most of the 20th century. Equipment had basic functionality, could operate effectively for decades and was sufficient to meet society's demands. Central to this approach was the design and installation of equipment to serve the highest demand, with some room for demand growth over the life of the equipment built-in. From a ratemaking perspective, it was

[100] For an example of DAC, see: Carbon Engineering, carbonengineering.com/.
[101] Primer on 45Q: Great Plains Institute, Primer: Section 45Q Tax Credit for Carbon Capture Projects, betterenergy.org/blog/primer-section-45q-tax-credit-for-carbon-capture-projects/#:~:text=Section%2045Q%20of%20the%20US,fields%20and%20saline%20formations%3B%20or; Department of Energy, Internal Revenue Code Tax Fact Sheet, energy.gov/sites/prod/files/2019/10/f67/Internal%20Revenue%20Code%20Tax%20Fact%20Sheet.pdf; The Clean Air Task Force, The Role of 45Q Carbon Capture Incentives in Reducing Carbon Dioxide Emissions, catf.us/wp-content/uploads/2017/12/CATF_FactSheet_45QCarbonCaptureIncentives.pdf.

also cost-effective because equipment designed to meet future growth in demand reduced the long-run average costs, which benefited ratepayers.

Technological advancements (like communications and system controls) have impacted the usefulness of equipment on the grid as demand and capabilities have increased, upsetting the current regulatory framework that focuses on installing assets that last for several decades.[102] Fixed costs will most likely need to rise to adapt and update the grid for the future and cover past deferred investments. As currently designed, grid costs are recouped through electricity rates collected over a long period with fixed charges and volumetric rates. Historically, the majority of investment in electricity infrastructure was collected through volumetric rates. Recovery of fixed costs primarily based on volumetric rates isn't sustainable in a future environment where the equipment's value is likely determined by shorter-term usefulness. With grid system threats and computer processing capabilities, communication devices and system control equipment will have to be replaced at least once per decade. As technology progresses, that may extend to assets that have historically had a longer useful life. Recovery of costs over 30 years will no longer be a viable option.

A higher portion of costs will need to be recovered in a fixed or non-bypassable manner. In a restructured market, a gradual shift to higher recovery of fixed costs in a shorter time is necessary to ensure that the system can be maintained and offer the capabilities to meet growing policy and consumer demands. Also, infrastructure investments deferred over the past few decades to reduce costs will need to be recovered. The *American Society of Civil Engineers* completed Maryland's "Report Card" in 2020, giving the state's energy infrastructure a "C-."[103] The already dilapidated condition of energy infrastructure will play a role in planning processes in the future, especially since, regionally, Maryland is part of a region that already requires the most infrastructure spending.[104] The national system itself is already at a projected investment shortfall of $208 billion by 2029, and $338 billion by 2039.[105] Increased stakeholder coordination will be necessary going forward, as the state will need to balance the usefulness of

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[102] This includes DERs which have the capability to place undue strain on the grid, and the increased integration of EVs which may lead to further strain. For EVs, see: Matteo Muratori, Impact of uncoordinated plug-in EV charging on residential power demand, *Nature Energy* 3, 2018, 193–201.
[103] Overall infrastructure in the state was graded "C," but energy was a C-: American Society of Civil Engineers, Maryland's 2020 Infrastructure Report Card, infrastructurereportcard.org/wp-content/uploads/2016/10/Maryland-ASCE-Report-Card-2020-Full-Sections.pdf.
[104] Energy Information Administration, Distribution system costs: eia.gov/todayinenergy/detail.php?id=36675 and Transmission system costs: eia.gov/todayinenergy/detail.php?id=34892; overall state of energy infrastructure in the United States: Department of Energy, Quadrennial Technology Review, Chapter 3: Enabling Modernization of the Electric Power System, 2015, energy.gov/sites/prod/files/2015/09/f26/QTR2015-3F-Transmission-and-Distribution_1.pdf, 3.
[105] American Society of Civil Engineers, Failure to Act: Electric Infrastructure Investment Gaps in a Rapidly Changing Environment, 2020, asce.org/electricity_report/ or asce.org/uploadedFiles/Issues_and_Advocacy/Infrastructure/Content_Pieces/Failure-to-Act-Energy2020-Final.pdf.

equipment upgrades and costs to ratepayers to facilitate evolving policy goals and a rapidly changing market structure. Toward that end, both MEA and the PSC have participated in a two-year task force that ended in December 2020. The Task Force focused on distribution system planning, with a key focus on integrating DERs to the grid and further opening the distribution planning process.[106] Both MEA and PSC will continue building on the process with broader stakeholder engagement in the PSC's distribution planning workgroup within Public Conference 44.[107]

Transmission and Distribution System Cybersecurity

A reliable and secure electric grid system is critical to economic and national security due to its important function in critical applications, including communications, water supply, and transportation. As the grid becomes more internet-connected, with grid modernization and smart appliances and systems, it also becomes more vulnerable to cyber attacks that could cause widespread infrastructure failures and blackouts. Advanced technologies applied to the grid have improved grid operation and made it more responsive, but have also increased how malicious actors can gain access to the grid and cause damage.

The Federal Energy Regulatory Commission (FERC) has jurisdiction over the bulk power grid, which includes mainly generation and transmission, and has developed cybersecurity standards for companies that fall under its jurisdiction. Congress approved the standards regime in the Energy Policy Act of 2005, section 215 of the Federal Power Act (FPA).

States generally have jurisdiction over electric distribution systems, with the State Utility Commission having regulatory authority over investor-owned utilities and electric cooperatives that operate these systems. In Maryland, the PSC has regulatory oversight over utilities, and their authority extends to setting cybersecurity standards. The PSC requires all Maryland electric, gas, or water companies serving 30,000 consumers or more to submit periodic cybersecurity reports. These reports include Cyber-security Plan Overview, Cyber-security Standards Adopted, Reporting Cyber Incidents, and Risk Management Process to Assess and Prioritize Cyber-security Risk. All Maryland electric, gas, or water companies must report cybersecurity breaches within one business day of confirmation.[108]

Transmission

FERC regulates the transmission of electricity in the United States. FERC is also responsible for regulating wholesale electricity sales and the reliability of high voltage transmission systems across the country. To construct transmission lines greater than 69 KV at the state level, a company must obtain a CPCN from the PSC and the appropriate FERC approvals. A thorough environmental and socio-economic impact assessment is conducted by PPRP as part of the

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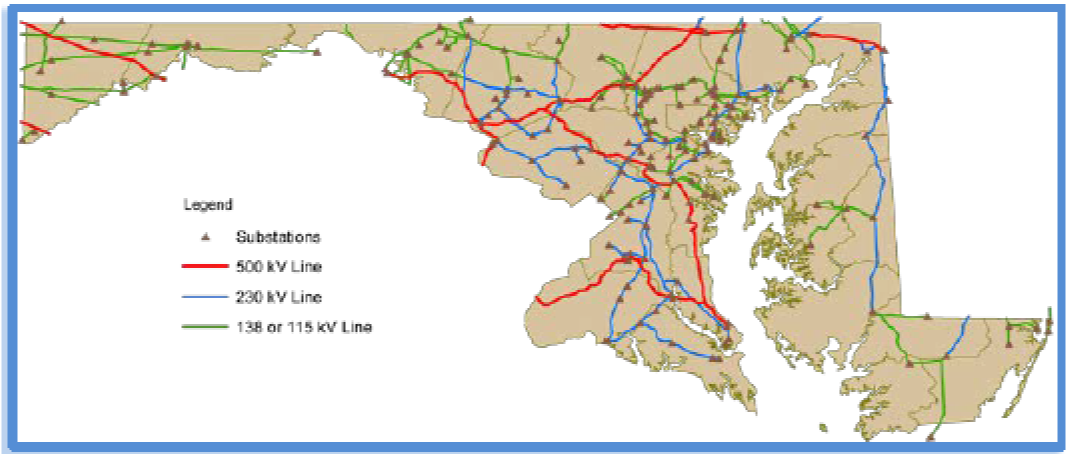
[106] National Association of Regulatory Utility Commissioners and the National Association of State Energy Officers, Task Force on Comprehensive Electricity Planning, naruc.org/taskforce/.
[107] MD PSC, PC44, Docket No. 255.
[108] MD PSC, ORDER NO. 89015

CPCN approval process for new transmission lines. Some of the recent CPCN transmission applications are shown in Appendix D

Transmission lines in Maryland (>115 kV)



Source: DNR, 2017[109]

PJM

PJM is a regional transmission organization (RTO) that coordinates wholesale electricity in all or part of 13 states and the District of Columbia. These states include Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. PJM manages the transmission grid and operates a competitive wholesale electricity market to ensure electricity supply reliability within its regional footprint. PJM also engages in long-term planning for transmission system upgrades to ensure reliability, economic benefits, and equal access to the grid.

There are three main types of competitive wholesale markets through which electricity is bought and sold in PJM. These markets include Energy Market, Capacity Market, and Ancillary Services. Each market serves a separate and distinct function to ensure the reliability of electricity supply:

Energy Market

The Energy Market is the largest wholesale market in PJM; it made up about 63% of wholesale electricity costs in 2018. The energy market constitutes the Day-Ahead and Real-Time market. Offers from power suppliers are matched from the lowest to the highest-priced seller with demand from power consumers. The Day-Ahead market is a futures market that sets energy prices delivered the next day while the Real-Time market satisfies electricity demand in real-time. Electricity prices are estimated every five

[109] DNR, 2017, Maryland Power Plants and the Environment: A review of the impacts of power plants and transmission lines on Maryland's natural resources, PPRP. dnr.maryland.gov/pprp/Documents/CEIR-19-Full%20Document.pdf

minutes based on the actual grid operating conditions in the Real-Time market. Suppliers are paid Day-Ahead prices for generation scheduled to be delivered and Real-Time prices for any generation greater than what was planned.

Capacity Market

The Capacity Market makes up approximately 20% of the wholesale electricity costs in PJM. The PJM capacity market is known as the Reliability Pricing Model (RPM). The capacity market secures energy resources three years in advance to ensure sufficient supply during periods of peak demand and emergency events, typically having a price-suppressive outcome on overall energy costs. PJM holds a competitive auction annually to secure these resources. The capacity market's cleared generation resources provide PJM emergency needs for the committed year and provide a foundation for the grid's reliability. It also gives generators incentive price signals to maintain existing resources or attract new generation investment by providing them with a guaranteed income flow in the future.

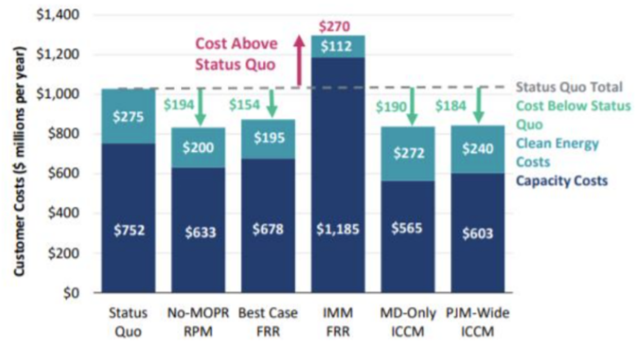


Chart from MOPR study from The Brattle Group prepared for MEA "Alternative Resource Adequacy Structures for Maryland". The full report is can be downloaded from Energy.Maryland.gov.

More recently, the PJM capacity market has been the subject of controversy, with a FERC order issued in December 2019. This order expands the Minimum Offer Price Rule (MOPR) to all resources that bid into the capacity market. MOPR is targeted at generation assets that receive state-level subsidies, in a sense, penalizing them for receiving those subsidies and forcing them to bid higher in the capacity auctions. This means that previously competitive, clean energy resources (typically subsidized by states) are no longer competitive and missing out on a potential revenue stream from the auctions. This has been a highly contentious issue that is continuing to evolve. There are ongoing legal challenges, and with new membership at FERC, a newly supplied PJM compliance order has been allowed to take effect, effectively mitigating the most consequential, negative components of MOPR. This is the result of a “fast track” stakeholder process at PJM.[110] PJM’s new rules exempt renewable resources and nuclear receiving state support from the MOPR, effectively allowing them to take part in PJM’s next capacity auctions. The rules took effect on September 29, 2021, under operation of law when FERC was unable to reach a decision on PJM’s filing.[111]

[110] PJM, https://pjm.com/directory/etariff/FercDockets/6239/20210730-er21-2582-000.pdf.
[111] FERC, https://elibrary.ferc.gov/eLibrary/filedownload?fileid=d7622403-f339-cd91-9467-7c31d0700000.

In March 2021, MEA finalized and released a report on MOPR, its impact on Maryland, and potential policy responses should it remain in place.

Ancillary Services Markets

Ancillary services are essential for maintaining the stability and security of the grid. These services include frequency regulation, synchronous and non-synchronous reserves, and black start operations. PJM dispatchers continuously ensure that electricity supply matches demand by frequency regulation and the use of reserves. Sudden fluctuations in the supply and consumption of electricity are corrected by frequency regulation. Ancillary services make up less than 1% of wholesale electricity costs, and help fine-tune the balance between supply and demand in the electricity system.

Reliability

Grid resilience and reliability underpin the transmission and delivery of all forms of front-of-the-meter electricity generation. With new sources of generation, need for flexibility, and aging infrastructure, it is important to have a strong focus on electricity reliability. In particular, this attention should be paid to local distribution infrastructure, given its age and useful life. Infrastructure upgrades will be necessary, and costly. Furthermore, with the impacts of climate change, it should be expected that there will be an increase in extreme weather events, necessitating a reliable grid that is able to withstand these more frequent events and maintain operations.[112]

In partnership with PJM and local distribution utilities, Maryland must be attentive to grid resilience or the ability to withstand and reduce the magnitude and duration of disruptive events. One example of a disruptive natural event was the June 2012 "derecho" storm that hit Maryland with sustained 70 mph winds, toppling trees and taking down 9,200 electric power lines. It took 8 days to fully restore power. Additionally, during the first week of January 2018, Maryland endured the coldest start to any year on record. A nearly two-week period of bitterly cold weather conditions caused by what meteorologists called a "bomb cyclone," an Arctic outbreak of cold weather, caused a failure of electricity generation infrastructure and widespread electricity outages throughout Maryland. The average temperature recorded at Baltimore-Washington International Thurgood Marshall Airport was just 15.2 degrees from January 1 through January 7.

The two incidents mentioned impacted transmission grid resiliency, and demonstrated the need to continually upgrade and harden the electricity grid. Some ways to improve grid resiliency and reliability include line coatings to prevent ice build-up, continual tree trimming, locating and

[112] Brian Stone Jr. et al., Compound Climate and Infrastructure Events: How Electrical Grid Failure Alters Heat Wave Risk, *Environmental Science and Technology*, 55, 2021, 6957-6964.

moving substations away from areas prone to flooding, building additional circuits and loops for redundancy, making critical facilities less critical, and selective burying of critical electric lines.

Transmission grid modernization is an essential component of a sustainable energy infrastructure that features accelerated deployment of renewables, especially electricity from variable output sources like solar and wind. The consideration of increases in Maryland's RPS from 25% by 2020 to 50% or, possibly, 100% is part of a larger reliability-related review process conducted by the North American Electric Reliability Corporation (NERC) that oversees and regulates the reliability of the North American Grid. NERC's specific mission is to ensure the North American Bulk Power System (BPS) reliability[113] and minimize significant power system disruptions. This reliability requires a balanced portfolio of diverse generation resources that provide adequate capacity and essential reliability services to meet consumer needs and support the overall system. NERC's authority extends to owners, users, producers, and suppliers to the bulk electric supply. NERC's reliability mandate must address both the benefits and the limitations for each generation resource type. Transmission planning must, by law, take these NERC priorities into consideration.[114]

Any time there are major shifts in the mixture of resources providing power to the grid, it can influence the grid's operational characteristics and present potential challenges and opportunities to reliable system planning and operation. NERC continuously monitors the reliability implications of coal and nuclear generation retirements, and the changing national and regional resource mix. It has already pointed out that coal and nuclear generation support reliability by providing dependable capacity, stability, and substantial essential reliability services in the form of inertia, voltage control, and fuel security. These attributes balance non-synchronous energy resources' variable characteristics and the fuel sensitivity of both non-synchronous and natural gas-fired resources.

While current and anticipated coal retirements in the state (and the region) are not a major concern at this time,[115] Maryland is approaching a point where it will need to take more seriously energy policy impacts on grid reliability. These concerns are amplified given the region in which

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[113] BPS refers to the generating and high transmission equipment that generate and deliver electricity to consumers across North America.

[114] North American Electric Reliability Corporation, Reliability Standards Development Procedure, Version 7, page 4, nerc.com/pa/Stand/Standard%20Process%20Manual%20DL/RSDP-V7_Clean_2009June9.pdf; Ibid., 2021 ERO Reliability Risk Priorities Report, nerc.com/comm/RISC/Documents/RISC%20ERO%20Priorities%20Report_Draft_Stakeholder_Input_as_of_June_8_2021.pdf.

[115] An important NERC study, stress testing coal and nuclear plant closures nationally, found that PJM has capacity for anticipated closures: North American Electric Reliability Corporation, Generation Retirement Scenario: Special Reliability Assessment, 2018, nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_Retirements_Report_2018_Final.pdf; NERC also runs these scenarios with the understanding there will be sufficient natural gas generation to provide load-balancing services: Ibid., 2017 Long Term Reliability Assessment, nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_LTRA_12132017_Final.pdf.

Maryland is located, surrounded by states that may also pressure coal facilities to shut down early and may not support nuclear generators' continued operation. Regional shutdowns of non-intermittent, baseload power of this magnitude will likely create regional grid reliability issues that are not easily remedied. Furthermore, abdicating any responsibility for Maryland on this issue due to the high level of electricity imports the state already receives, and the increase in imports the state would receive to compensate for lost generation, may be counterproductive since the state would simply be exporting its carbon-emissions problem across state lines. These concerns are enhanced as climate change-induced extreme weather occurs with greater frequency.

PJM determined that current transmission grid resources can provide reliability, but the potential concentration of a single fuel source or low-probability impact events could cause significant impacts to the system. PJM also created a "composite reliability index" to assess the operational reliability of various resource mixes across several PJM states as part of a sensitivity analysis, examining normal peak conditions, light load, extremely hot weather, and extremely cold weather. It determined the grid's current trajectory is headed toward potential deficiencies in frequency response, reactive capability, and fuel assurance but increases in flexibility and ramping attributes.[116] The report goes on to state:

> A marked decrease in operational reliability was observed for portfolios with significantly increased amounts of wind and solar capacity (compared to the expected near-term resource portfolio), suggesting de facto performance-based upper bounds on the percent of system capacity from these resource types. Additionally, most portfolios with solar unforced capacity shares of 20% or greater were classified infeasible because they resulted in LOLE [Loss of Load Expectation[117]] criterion violations at night. Nevertheless, PJM could maintain reliability with unprecedented levels of wind and solar resources, assuming a portfolio of other resources that provides a sufficient amount of reliability services.[118]

The report noted that portfolio mixes with the largest unforced capacity shares of weather-dependent wind and solar tended to have the lowest composite reliability indexes and that the composite reliability indices generally improved as unforced capacity shares of nuclear, coal, and natural gas increased (as baseload generation increased). The report also noted that as coal and nuclear units were retired and replaced, portfolios with the highest composite reliability indices tended to be ones in which natural gas is the predominant replacement resource.[119] When grid engineers study electricity transmission, they must take all impacts into account and integration solutions associated with variable renewable energy (VRE) are no

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[116] PJM Interconnection, PJM's Evolving Resource Mix and System Reliability, 2017, pjm.com/~/media/library/reports-notices/special-reports/20170330-pjms-evolving-resource-mix-and-system-reliability.ashx.
[117] Note: LOLE refers to the Loss of Load Expectation (LOLE) and is a measure of the security of supply for the entire PJM footprint.
[118] Ibid., 5.
[119] Ibid.

different, given their unique challenges. The challenge is their intermittency (i.e., their change in output over various timescales due to the underlying fluctuations in the resource) and uncertainty (i.e., the inability to perfectly predict resource availability and generator output). VREs amplify inherent variability and uncertainty on the aggregate system and require changes to systems operations and physical infrastructure in order to properly manage their deployment.

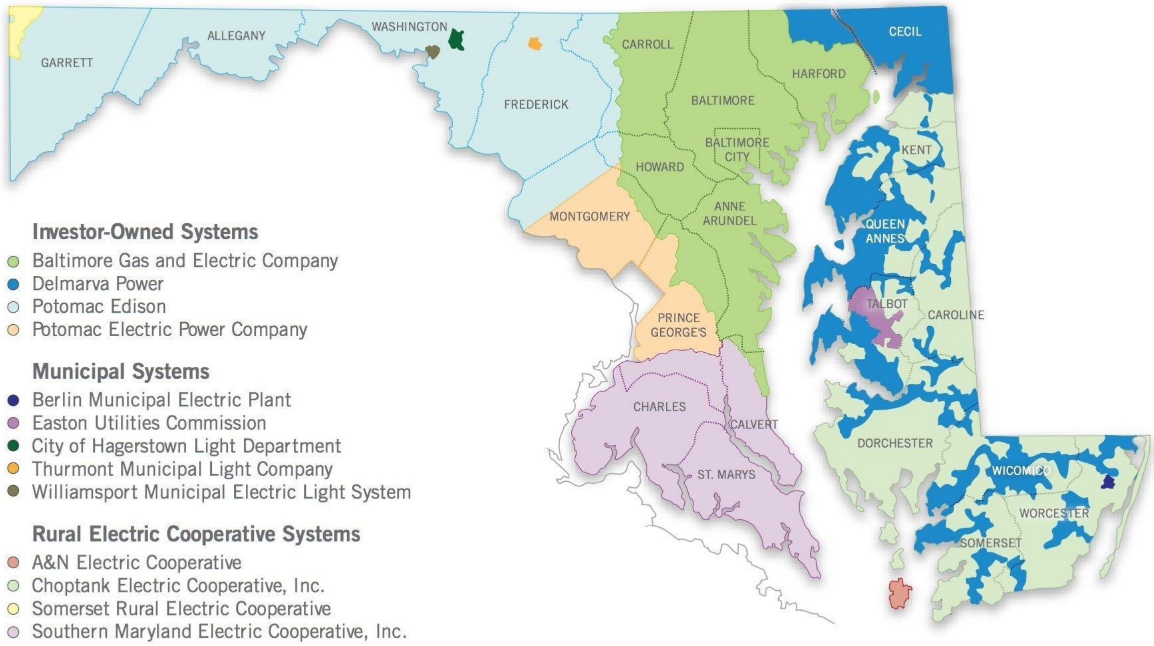
Additionally, all of the individual utilities located within PJM, or any RTO or Independent System Operator (ISO), must make the necessary changes and upgrades to strengthen their capabilities: control centers, which include the digitization, smart meters, intelligent switches, and relays; registration of third party DERs assets with available telemetry to a control center; upgrades of connectivity to keep pace with new VRE resources; dispatching grid-scale storage assets remotely to provide load balance; and, new transmission line infrastructure are an integral part of a 21st-century electricity transmission grid.

Distribution

The distribution system is different from the transmission system. The distribution system is the typically shorter range and lower voltage network responsible for delivering the actual electricity into a household or business. It is a local network with wires that reach anywhere there is power usage. The transmission system, in comparison, typically transmits electricity at higher voltages and across greater distances, usually across states or national regions. While PJM manages the long-distance transmission infrastructure, local utility companies, with which most people are familiar, manage the short-range distribution network that carries electricity into homes.

In Maryland, there are 13 electricity distribution utilities. Four of these are investor-owned utilities (IOUs), namely Baltimore Gas and Electric Company, Delmarva Power, Potomac Edison, and Potomac Electric Power Company, serving about 90% of Maryland consumers. There are also five municipal utilities, namely Berlin Municipal Electric Plant, Easton Utilities Commission, City of Hagerstown Light Department, Thurmont Municipal Light Company, and Williamsport Municipal Electric Light System. The remaining utilities are rural electric cooperatives including, A&N Electric Cooperative, Choptank Electric Cooperative, Somerset Rural Electric Cooperative, and Southern Maryland Electric Cooperative. The jurisdictions where these utilities operate are shown in the figure below.

Distribution Utilities in Maryland



Source: PSC, Ten Year Plan 2019-2028 of Electric Companies in Maryland.

The distribution system is an integral part of the energy infrastructure system that delivers energy to customers. Traditionally, the distribution system's operation is carried out by the local distribution company or load-serving entity (LSE). In recent years, market changes have demanded that the system be more flexible and accommodating to new technologies such as PV, EVs (EV), and energy storage, to name a few. These accommodations have not changed the LSE's obligation to serve and maintain a safe, reliable system, but it has increased its challenges as well as opportunities. Furthermore, facilitating the increased use of DERs on distribution systems may present challenges as well.

On the other hand, a more flexible distribution grid allows end-use customers to deliver valuable services to the system, such as increased reliability, resiliency, and opportunities to reduce costs through efficiency improvements and greater customer control. Developing a distribution system that allows two-way communication between LSEs and end-use customers can further improve distribution reliability, resiliency, and system operations. The design of rates should be coordinated with the market changes and allow for innovation to ensure cost recovery and reduce market distortions.

Maryland Energy Administration

Maryland

ENERGY CONSERVATION AND EFFICIENCY

MAY 2022

DEVELOPED BY
Maryland Energy Administration

Energy Conservation and Efficiency

Introduction

Diverse, flexible, and well-capitalized energy efficiency programs are essential to foster an energy efficiency marketplace that will enable Maryland to meet its energy conservation targets. Public benefits associated with energy efficiency and demand response programs include electricity cost savings, jobs, revenue created by the energy efficiency services sector, and reductions in GHGs and other air pollutants. The below sections cover both the established statewide initiatives and potential avenues to deploy additional energy efficiency programs and policies.

Current State Initiatives

The State of Maryland has several energy or energy-related initiatives that overlap and could benefit from increased coordination and collaboration among the stakeholders. Maryland currently generates a significant amount of energy from fossil fuels, which have environmental impacts. The state has established GHG reduction goals to help reduce these impacts as well as goals to increase generation from renewable energy resources through Maryland's RPS. These initiatives could create redundancies and increase costs to residents in Maryland if implemented separately. The two initiatives' underlying tenets are to improve the quality of life for residents in the state by reducing negative environmental impacts and positioning the state to transition to a cleaner energy profile. Although the initiatives were adopted in separate legislation to capitalize on efficiencies, the planning and timing of the activities should be carried out in a complementary manner to reduce costs. A successful transition to a cleaner energy profile will have the added benefit of expanding related industries in the state and generating jobs for residents.

In addition, even though energy efficiency programming is expected to continue beyond the current 2% electricity savings mandate, which expires in 2023, Maryland has an opportunity to reorient the energy goals to align with the different initiatives in the state. By seeking broader energy goals aligned with the existing initiatives and trends in the energy sector, the state can position itself to achieve the goals at a lower cost through a coordinated effort. The coordination of the initiatives should also include identifying and assigning value to the desired market attributes and market characteristics that contribute to negative environmental externalities. Identification and valuation will generate the appropriate signals to the market participants to influence consumers' behavior and incentivize investors' spending. The state can strategically address existing imbalances in the market by adjusting the incentives toward targeted behavior. For instance, DERs can be targeted to sections of the electricity grid to reduce energy demand and demand-related energy charges.

EmPOWER Maryland[120]

In enacting the EmPOWER Maryland Energy Efficiency Act in 2008, the General Assembly noted that "energy efficiency is among the least expensive ways to meet the growing electricity demands of the state."[121] EmPOWER programs can provide cost-effective, long-term benefits, including reduced energy consumption and rates, avoided investments in energy transmission and distribution, job creation, and improvements to the environment. The law originally set targets of reducing electricity consumption and demand per capita by 15% by 2015. The implementation of the law included programs managed by five electric utilities: Baltimore Gas and Electric Company (BGE), Potomac Edison Company (PE), Delmarva Power & Light (Delmarva), Potomac Electric Power Company (PEPCO), and Southern Maryland Electric Cooperative, Inc. (SMECO), with the Department of Housing and Community Development (DHCD) implementing the low-income programs.

Cumulatively, the utilities met 99% of the original EmPOWER energy reduction goal and 100% of the demand reduction goal assigned by the PSC. The entire State of Maryland, including all utility service territories, had reduced electricity consumption on a per capita basis by 14.92% at the end of CY17. PSC Order No. 87082, issued in July 2015, created a new framework for EmPOWER electric savings goals from 2016 to 2020, with a goal adopted statutorily in 2017 by the General Assembly, based on that order. The commission ordered that the electric utilities achieve annual incremental gross energy savings of 2% of weather-normalized retail electricity sales per year. The PSC established electric savings targets for 2017, and ordered that the utilities ramp up annual energy savings at a rate of 0.2% per year to achieve 2% total annual savings by 2020. The EmPOWER Program uses a three-year planning cycle to develop program budgets and programs and is funded through a monthly surcharge on ratepayers' electric and gas bills.

Although the EmPOWER Maryland program has benefited the state by achieving significant energy savings through reduced energy consumption and energy demand, the program's costs have also been high. As of 2019, the program-to-date spending on all programs was $2.8 billion. However, due to the five-year cost recovery structure for program costs, more than $800 million is still uncollected from ratepayers - not including interest costs. Despite the benefits provided by the energy efficiency and conservation programs in EmPOWER, the program costs and uncollected program costs present a challenge to energy efficiency going forward.

SEIF-Funded Energy Programs

Through the SEIF, Maryland directly implements energy programs. MEA carries out a number of the SEIF-funded programs focused on energy efficiency, including energy efficiency targeted specifically at LMI Maryland residents; renewable energy, including offerings targeted at residential households; and clean transportation. MEA's suite of energy programs includes the

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[120] The EmPOWER Maryland Energy Efficiency Act (codified at Md. Code Ann., Public Utilities § 7-211).
[121] Id.§ 7-211(b).

Maryland Smart Energy Communities Program, which assists participating counties and local governments in adopting and achieving clean energy goals. Other state agencies offer energy-related programs that receive SEIF, such as the Department of Human Resources (DHR) that implements energy bill assistance. More information on SEIF uses can be found in the FY20 SEIF report.[122]

State Facilities

In FY20, the state paid over $150 million for electricity and natural gas usage in state facilities, or approximately $410,000 per day.[123] On June 25, 2019, Governor Hogan signed Executive Order 01.01.2019.08, which seeks to reduce energy consumption in state-owned facilities by 10% in 2029 from a 2018 baseline. The "Maryland Leads by Example" Executive Order directs the Maryland Department of General Services (DGS) and MEA to develop and manage an energy savings initiative in state-owned buildings. DGS has been tasked to annually audit state-owned buildings determined to be the least energy-efficient to accomplish this goal. The audit shall identify low-cost measures for increasing energy efficiency and savings while reducing future costs and expenses. By having energy reduction targets incorporated into each state agency's goals and objectives, the state can lead by example in reducing energy usage, cost, and GHG emissions.

Energy Tracking

Since 2008, DGS has been tracking energy consumption and cost for 100% of state facilities in a publicly available online database. The database tracks over 14,000 active utility accounts. It includes over 1.6 million utility bill records and all commodities, including electricity, natural gas, fuel oil, propane, steam, chilled water, and water and sewer. This information has been essential in documenting and benchmarking state energy usage.

Energy Performance Contracting (EPC)

Maryland has a long history of pursuing EPC projects that foster energy efficiency within state facilities. Many states, as well as local and county governments, may need to replace or upgrade aging, inefficient, and obsolete energy and water-consuming equipment. EPCs, first and foremost, allow agencies to implement energy and water-saving projects that budget constraints would otherwise prevent. Under an EPC, an Energy Services Company (ESCO) identifies potential energy and water conservation upgrades. Proposed efficiency upgrades can be financed by the cash flow of future utility and maintenance cost savings. An ESCO's services include project development, financing, training, and commissioning. A key element with EPCs is that the ESCO provides corporate guarantees that the energy and water savings, which must be measured and verified at specific intervals, will cover project costs. The ESCO contractually guarantees annual energy savings. Currently, DGS manages over 25 separate EPCs that will save $322 million across the contracts' life.

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[122] Ibid.

[123] EnergyCap, app.energycap.com/app/dashboards/user/2211.

Energy Codes

Energy codes are historically the most cost-effective way to reduce energy consumption from new or substantially renovated buildings. Energy performance guidelines for new construction in Maryland are outlined in the Maryland Building Performance Standards Regulations (MBPS), see COMAR 09.12.51. Per MBPS, the state must implement the International Code Council's model code, known as the International Energy Conservation Code (IECC), which is updated triennially. Maryland is currently following the IECC 2018 version. The state's High-Performance Buildings Act provides additional energy conservation guidelines to buildings wholly owned and funded by state agencies or local education agencies.

The 2021 code, finalized in April 2020 by the International Code Council (ICC), for which the state will initiate the adoption process shortly, includes a significant number of improvements that will foster more efficient buildings. The updated code covers major building components, including building envelope, lighting, water heating, and is likely to drive substantial gains for newly constructed buildings. The state establishes the base code, and local governments adopt it at the local level and may increase but not decrease stringency.

MEA is working with NASEO and other groups to evaluate options to coordinate efforts to ensure that the ICC is aware of the importance of energy codes to state and local energy efforts, and that energy-efficiency concerns are balanced with the need for consistency and achievability by the building design and construction community. The conversion of the code to a "standard" will require a different engagement strategy and coordination amongst stakeholders, including the Department of Labor and local jurisdictions having authority.

Energy Equity and Assistance

On average, Maryland households have an average electric bill of $127.92 per month, equating to $1,535 per year in electricity costs alone,[124] not including any types of fossil fuels that may be used for home heating purposes. While this is the average, the actual energy cost for any individual home will vary based on the type, size, and condition of the home and building systems, as well as the electric supplier or utility. DHCD operates the Weatherization Assistance Program. The program "helps eligible low-income households across the State of Maryland with the installation of energy conservation materials in their dwelling units" and is funded "by the U.S. DOE, Low Income Home Energy Assistance Program, the SEIF, and participating EmPOWER Maryland utility companies."[125] DHCD partners with local agencies across the state to administer the energy services offered in the program. Participants must meet eligibility requirements and prove ownership of the housing unit or obtain approval from the property

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[124] U.S. Energy Information Agency (EIA), 2019 Average Monthly Bill- Residential, eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf, accessed 12.31.18.
[125] Maryland Department of Housing and Community Development. dhcd.maryland.gov/Residents/Pages/wap/default.aspx.

owner.[126] "Priority is given to eligible applicants who are elderly, disabled, have families with children, and have the highest energy consumption."[127]

Maryland is committed to reducing the energy burden of LMI households. The average American spends approximately 3% of their income on energy. In contrast, low-income and rural populations can spend 20% or more of their income on energy.[128] Maryland needs to continue to be cognizant of the home energy affordability gap and focus on greater energy equity and resilience in our communities to assure fair and impartial access to cleaner, reliable, and affordable energy.

It is equally important that the state's ongoing energy initiatives and future energy initiatives include increasing the transparency of retail price information to facilitate customer comparison of utility and competitive service provider's pricing today and into the future.

Finally, improving health and safety as a result of these programs is of the utmost importance. An important part of Maryland's energy plan is the emphasis on improving cost-effective energy affordability for LMI consumers while increasing the deployment of DERs with LMI communities and providing well-paid clean energy jobs.[129] Maryland has created an effective LMI Energy Efficiency grant program, administered by MEA. The program is designed to support energy efficiency projects and activities for LMI Marylanders while building community-based capacity and, in many cases, job creation. Low-income residents have also been able to apply for weatherization and energy-related home repair funding through DHCD. These initiatives will continue to be an essential part of the Maryland energy plan.

Energy Financing

Essential to achieving the state energy goals is expanding the array of financing options available to government, businesses, and residents. A substantial injection of private capital widely available at terms commensurate with the potential energy and GHG savings is essential to achieve scale.

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[126] Ibid.
[127] Ibid.
[128] ACEEE, The High Cost of Energy in Rural America: Household Energy Burdens and Opportunities for Energy Efficiency, aceee.org/sites/default/files/publications/researchreports/u1806.pdf. A recent MD OPC study also found income-eligible households pay rough 15% of their income towards energy costs: Applied Public Policy Research Institute for Study and Evaluation, Maryland Low-Income Market Characterization Report, opc.maryland.gov/Portals/0/Publications/reports/APPRISE%20Maryland%20Low-Income%20Market%20Characterization%20Report%20-%20Octber%202018.pdf?ver=2019-09-10-150223-853.
[129] The approximately $9 million dispersed in the 2017 program realized significant savings in 2,650 buildings while enabling 95,000 job hours for those involved with installing the energy efficiency measures. energy.maryland.gov/govt/Pages/LMI2017.aspx&sa=D&ust=1591210080218000&usg=AFQjCNEH6jjWRnGzrxOQZGs_fxfnDtl1Wg.

In addition to administering programs of its own to expand the availability of capital, MEA is working with stakeholders to identify opportunities for expanding the pool of capital and developing programs that address market gaps that are not currently met by existing private or public programs. Specifically, programs that address consumers who do not have the liquidity, either due to credit availability or inability to meet payment obligations, are essential to developing an inclusive clean energy economy.

MEA is working with stakeholders to identify market gaps and options to expand the array of financing options at favorable terms, focusing on those who cannot access traditional financing sources without duplicating effective and reasonable cost offerings already available to consumers.

Several Programs active in Maryland include:

MD-PACE

MD PACE is a statewide commercial property-assessed clean energy (C-PACE) program that provides turn-key, low-cost, standardized C-PACE program services to property owners, capital providers, contractors, and local governments in the state.[130] C-PACE is a financing structure in which building owners borrow money for energy efficiency, renewable energy, or other projects and make repayments via an assessment on their property tax bill. The financing arrangement then remains with the property even if it is sold, facilitating long-term investments in building performance. Maryland passed a policy enabling Commercial PACE (C-PACE) in 2014. The law requires that local ordinances then be passed, enabling C-PACE financing within the participating jurisdiction. Since C-PACE is administered at a local level, counties can opt into the MD-PACE Program or administer their program through other means. Of all jurisdictions in Maryland with C-PACE, only two, Montgomery and Prince George's counties, have not opted into the MD-PACE Program. They opted to operate a county-administered system.

Montgomery County Green Bank

The Montgomery County Green Bank currently administers Montgomery County's C-PACE program and Clean Energy Advantage (CEA) Program. Montgomery County Green Bank's CEA Program has low-cost financing options through participating lenders offering specially tailored loans for Montgomery County homeowners.[131] This program was funded by the proceeds of the Pepco/Exelon merger and is designed to provide flexible financing. The Montgomery County Green Bank and emerging efforts are being monitored for cost-effectiveness in attracting private capital. Green Bank efforts are sensitive to risk and require substantial subsidies to mitigate risks to reach a broader range of consumers than the private market currently can, ensuring that programs

[130] Maryland Commercial PACE, md-pace.com/.
[131] Montgomery County Green Bank, mcgreenbank.org/energy-efficiency/.

appropriately serve new customers who cannot finance projects due to cash liquidity issues or are hesitant to access current private offerings is essential.

Jane E. Lawton Conservation Program

The Jane E. Lawton Conservation Loan program makes loans available to eligible Maryland nonprofit organizations, local governments, Maryland businesses, and state agencies to implement cost-effective energy efficiency and conservation improvements.[132] One recent recipient, Marlin Steel, received a Lawton Loan and a Commercial Industrial and Agricultural grant in 2017. Read more about this project [here](#).

Marlin Steel was awarded both a Commercial Industrial and Agriculture grant and a matching Lawton Loan in fiscal year 2017 from MEA to complete lighting, air compressor and welding system upgrades to yield an annual energy savings of 252,403 kilowatt hours or enough energy to power 12 Maryland homes.

Maryland Agricultural and Resource-Based Industry Development Corporation (MARBIDCO) Loan Programs

MARBIDCO utilizes RGGI funds to offer affordable financing for projects to improve energy efficiency in food and fiber businesses.[133] The program's goal is to help rural businesses reduce energy consumption and, at the same time, increase profitability.

Maryland Clean Energy Capital (MCAP) Program

This program brings clean energy and efficiency financing solutions to government, institutions, and nonprofit entities.[134] MCAP can provide projects with access to lower-cost capital and an advantageous finance structure.

Appliance Standards

Appliance Standards offer one of the lowest-cost opportunities for reducing energy consumption and consumer energy costs with little to no initial costs to consumers. While many pieces of equipment have federally established energy standards, some appliances do not. In the absence of a federal standard, individual states may establish energy standards and help their residents reduce energy waste and lower energy bills. The Appliance Standards Awareness Project (ASAP) has identified new potential appliance standards that, if fully adopted in Maryland, could ultimately result in avoidance of more than 194 GWh of annual electricity usage, 573 BBtu of

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[132] energy.maryland.gov/Govt/pages/janeelawton.aspx.
[133] Maryland Agricultural and Resource Based Industry Development Corporation, marbidco.org/_pages/programs_loans/loan_programs_rbeeil.htm.
[134] Maryland Clean Energy Center, mdcleanenergy.org/finance/mcap/.

natural gas usage, and $84 million in utility bills by 2025, in addition to the corresponding GHG and water reductions.[135] Appliances that could be considered for appliance standards include commercial steam cookers and dishwashers, faucets, and showerheads, all of which were determined by ASAP to have payback periods of 1.1 years or less.[136] In particular, showerheads and faucets seem to be excellent candidates for a possible appliance standard, with payback periods of zero years.[137]

Light Emitting Diode Streetlight Energy Efficiency

A grant awarded to MEA by the DOE enables technical assistance to communities seeking to upgrade their streetlights to energy-saving LED technologies. By opting into this 3-year program, a municipality would receive no-cost technical assistance for developing fixture inventories, conducting investment analysis, selecting procurement and finance options, and crafting suitable legislative and regulatory strategies. The grant, however, does not provide the capital to acquire and install fixtures. To date, 15 municipalities in Maryland have ratified commitment letters that entitle them to receive program assistance.

Substantial progress has been made in converting streetlights to efficient technologies. MEA recently published a report providing an overall assessment of the status of the street lighting market in Maryland. For example, according to the report's analysis of data provided by BGE, 72% of utility-owned street lights have been replaced with LEDs.[138] Replacements in other utility territories vary in effectiveness and are hindered by the complex array of ownership models that impact how the costs and ultimately benefits of improvements are realized.

Streetlights can largely be divided into those owned by the customer (e.g., municipality) and serviced by the utility, and those owned and serviced by the utility. Streetlights are typically unmetered, and savings are dependent on a number of assumptions relative to the savings potential of a specific lighting fixture, the costs of utility infrastructure servicing the lights, and the amortization of stranded investment. Utility-owned street lighting is particularly sensitive to stranded investment because of rapid improvements in technology and potential savings.

The rapid expansion of street lighting retrofits in Maryland depends on the development of tariffs that fairly allocate costs and benefits while ultimately providing savings and increased

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135 Appliance Standards Awareness Project, State savings from state standards, appliance-standards.org/state-savings-state-standards, accessed February 5, 2021.

136 Appliance Standards Assistance Project, 2021 State Appliance Standards Recommendations, Savings Estimates for: Marland, appliance-standards.org/sites/default/files/state_savings_state_standards/Maryland.pdf.

137 See Environmental Protection Agency explainers: WaterSense High-Efficiency Lavatory Faucet Specification Supporting Statement, epa.gov/sites/production/files/2017-01/documents/ws-products-support-statement-faucets.pdf and WaterSense Specification for Showerheads Supporting Statement, epa.gov/sites/production/files/2017-01/documents/ws-products-support-statement-showerheads.pdf.

138 LED Streetlight Conversions in Maryland & Virginia - Opportunities, Challenges, and Strategies in 2020 news.maryland.gov/mea/wp-content/uploads/sites/15/2020/10/FINAL-LED-Streetlights-in-Maryland-20200929.pdf

value to customers. Several utilities, including the Pepco/Exelon family are proposing the introduction of smart street lighting technologies that increase potential value.

Yet, at the same time, local governments can easily leverage their streetlight experience to pursue cost-saving upgrades of lighting for parks, parking lots, and athletic fields.

New School Construction

MEA has been administering the Net Zero Energy school program for several years. After a full year of operation, Maryland's first net-zero energy public school, Wilde Lake Middle School in Howard County, was successfully verified. The two other net-zero energy schools participating in the program, both in Baltimore City, recently finished construction and are now open, though under modified operations due to the COVID-19 pandemic.

Graceland Park / O'Donnell Heights elementary and middle school opened in September of 2020 and is one of three net zero energy schools in Maryland partially funded by MEA, photo credit: Baltimore City Schools

The net-zero energy project at **Wilde Lake Middle School** successfully achieved net-zero energy status by incorporating energy efficiency from the earliest stages of the design process to reduce the building's overall energy demand. Building system commissioning completed post-construction was then used to ensure that the desired level of energy performance was achieved. Renewable generation was then added to meet or exceed the building's minimized energy load. MEA has supported the construction of three net-zero energy schools in the state with a total of $7.9 million awarded to Wilde Lake Middle School in Howard County and Graceland Park/O'Donnell Heights Elementary/Middle School and Holabird Academy in Baltimore City over the past four years.

In parallel, Maryland has a High-Performance Green Building Program established by the Maryland Green Building Council.[139] One of the Maryland Green Building Council goals is "promotion and creation of energy-efficient buildings throughout the State of Maryland."[140] The High-Performance Green Building Program impacts new and replacement public school construction receiving state funds. The program requires that the new schools be designed, built, and constructed to meet the requirement for at least the Leadership in Energy and Environmental Design (LEED) Silver rating, the International Green Construction Code (IGCC), or the Green Globes protocol of the Green Building Initiative. While LEED and Green Globes provide frameworks for designing greener buildings, the point structures favor buildings that benefit from certain local attributes, such as access to public transportation that may not be uniform across the state. Codes and standards such as IECC and IGCC place a greater emphasis on energy performance and less on geographic elements.

[139] Department of General Services, Maryland Green Building Council Annual Report, dgs.maryland.gov/Annual%20Reports/2018GreenBldgCouncilReport.pdf, page 3.
[140] Ibid., page 4.

As the state contributes anywhere from 50% to 100% of funding for eligible costs of approved public school construction projects through the Maryland Public School Construction Program, [141] it could encourage new public schools to be built in a manner that supports the state's energy and resiliency goals and minimizes lifecycle operating costs.

Demand Response Programs

The EmPOWER Maryland Energy Efficiency Act of 2008 established a 15% demand reduction per capita goal by 2015. The participating electric utilities were to deliver cost-effective demand response programs to achieve the goal. The demand reduction goal was achieved by the utilities in 2015.[142] As stakeholders developed post-2015 goals for energy efficiency and energy conservation, the decision was made to exclude a demand reduction goal due to uncertainty and pending litigation of FERC decisions.[143] However, the participating utilities continue to offer demand response programs to ratepayers in the service areas through Direct Load Control (DLC). Customers can voluntarily sign up for demand response programs that allow the utilities to install equipment that cycles air conditions and electric heat pumps during times of uncertain reliability or spiking electricity prices. A subset of the participating utilities also offers dynamic pricing programs.[144] These programs allow the customers to reduce load at a specific time, usually at points of high grid stress (usually in the summer). This at-will demand reduction reduces load constraints, helping to maintain grid stability. In exchange for the reduced load, the utilities offer installation equipment incentives and bill credits to these customers. This is not a permanent efficiency gain, but it does allow the utilities to flexibly reduce grid strain, which reduces aggregate consumption and costs at critical periods for the system.

Recent Technology and Policy Trends

Electrification

Strategic electrification is defined by the Northeast Energy Efficiency Partnerships (NEEP) as: "powering end uses with electricity instead of fossil fuels in a way that increases energy

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[141] Maryland Public School Construction Capital Improvement Program, FY22 Public School Construction Allocations, Approved by the Interagency Committee on Public School Construction, Published December 31, 2020
iac.mdschoolconstruction.org/wp-content/uploads/2021/01/Entire-FY-2022-CIP-Document-010421.pdf.

[142] PSC, The EmPOWER Maryland Energy Efficiency Act
Report of 2016 at 3.
psc.state.md.us/wp-content/uploads/2016-EmPOWER-Maryland-Energy-Efficiency-Act-Standard-Report.pdf

[143] PSC Order 87082 at 29.

[144] PSC, The EmPOWER Maryland Energy Efficiency Act
Report of 2020 at 13.
psc.state.md.us/wp-content/uploads/2020-EmPOWER-Maryland-Energy-Efficiency-Act-Standard-Report.pdf.

efficiency and reduces pollution, while lowering costs to customers and society, as part of an integrated approach to deep decarbonization."[145]

Targeted electrification in buildings focuses on the displacement and replacement of fossil fuel equipment used for space heating and cooling, as well as hot water with heat pump technologies. These technologies have improved in performance and cost-effectiveness in recent years. However significant gaps exist in the body of knowledge regarding how these systems perform in various situations (e.g., climate, varying building types and uses) and how that relates to affordability in real world applications at scale. More granular data is needed to understand the role of strategic electrification as a tool for reducing GHG emissions. The preferences of consumers for performance characteristics for different fuels should not be underestimated and forcing policies that lead to reduced comfort, cost or function may negatively impact opportunities for adoption when the technology is viable and may discourage consumers from taking other actions.

There are many options for the building sector, including reducing space heating load through increases in efficiency, including deep energy retrofits in existing buildings and construction of zero net-energy homes, and leveraging community solar as an offsite option as an alternative strategy to strategic electrification in buildings.

Electrification is not a sole solution as technologies for large commercial and industrial applications are still evolving, and ready made replacements may not be available for many years. Electrification efforts will need to be closely monitored to ensure that the solution provides cleaner, reliable and affordable energy for consumers while understanding impacts to current natural gas ratepayers. To achieve GHG reductions, strategic electrification is wholly dependent on Maryland's electricity grid transition to cleaner energy sources and energy storage.

Caution must be advised in focusing on any one approach at the cost of a potentially more impactful and cost-effective approach using a variety of technologies. In some situations electrification may be an option to reduce GHG emissions, but also may sacrifice affordability, performance and erode reliability by consolidating energy use to a more limited number of fuels, transmission and distribution resources.

Challenges to Energy Efficiency

Energy efficiency and conservation will continue to play a vital role in the electricity industry, even as future challenges increase. After more than 10 years of encouraging market innovation and providing incentives for ratepayers through EmPOWER Maryland, the easy-to-achieve energy savings are almost exhausted. Lighting and behavior-based programs continue to

[145] Northeast Energy Efficiency Partnerships, Strategic Electrification: An Energy Transformation, neep.org/blog/strategic-electrification-energy-transformation

provide cost-effective means of energy reduction; however, market saturation of efficient light bulbs and interactive and smart devices may be outpaced by growing electricity demand in the upcoming decade.

Additionally, although EmPOWER Maryland has benefited the state by achieving over 10 million MWh of energy savings, valued at over $10 billion,[146] through reduced energy consumption and energy demand in the state, the program's costs have also been high. As of 2019, the program-to-date spending on all programs was $2.8 billion. However, over $800 million is still being collected from ratepayers due to the five-year cost recovery structure for program costs. Utility funds also finance the programs, so each year, utilities receive interest on the uncollected program costs at the rate of their weighted average cost of capital - the estimated total interest to be paid to the utilities annually is currently over $50 million. Despite the benefits provided by the energy efficiency and conservation programs in EmPOWER, the program costs and uncollected program costs present a challenge to energy efficiency going forward.

The grid itself will be another important factor. Providing clean energy to customers will hinge on the grid and infrastructure's ability to accommodate changing technology and the flexibility to incorporate the resources when needed and available seamlessly. Although there has been investment in the electric grid's aging infrastructure, the investment has not grown proportionately with the grid's increasing importance to society. Increasing demand for DERs also poses significant challenges as the current electricity rate design does not fully account for this trend and instead shifts costs to ratepayers that are incapable or unwilling to purchase DERs. If the grid is incapable of managing new, flexible technologies, it could have a negative impact on energy efficiency and aggregate demand. This is particularly acute given that DERs are behind-the-meter technologies responsible for reducing demand on the grid through more traditional means, i.e., power flowing one way from a power plant to a consumer. Increased use of DERs will be critical to bringing some of our future goals to fruition.

DER proliferation also clashes with traditional rate recovery mechanisms. These challenges need to be addressed to ensure that benefits and costs are distributed as intended across residents in Maryland. Historically, electricity infrastructure investments are recovered from ratepayers in the form of transmission and distribution rates. Current rate design and cost recovery allow DER owners to avoid grid infrastructure costs, which are then borne by other residents. Also, the upfront cost of installing DERs limits the pool of eligible candidates to ratepayers that support the goals and can even afford the out-of-pocket costs – with limited exceptions of programs sponsored by the state and nonprofit organizations. A cohesive strategy that implements the energy initiatives at the state level will reduce the likelihood of the proliferation of the DERs benefiting some residents at the expense of others.

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[146] PSC, The EmPOWER Maryland Energy Efficiency Act
Report of 2019,
psc.state.md.us/wp-content/uploads/2019-EmPOWER-Maryland-Energy-Efficiency-Act-Standard-Report.pdf.

The regulatory framework itself may need adjustment. The current framework, which focuses on the useful life of devices, instead of the usefulness of the devices, will result in outdated technology remaining in use on the grid for longer, while not taking advantage of the capabilities of new technologies that could be used to meet the evolving demand of residents and businesses in the state.

Equity Issues

EmPOWER program offerings are targeted at low-income households. However, there is no specific EmPOWER energy efficiency goal for low-income families who are most in need of energy savings and have limited financing options otherwise available. And, the approach of separating the energy efficiency programs based on the ratepayers' income classification has met several challenges over the years. For instance, identification and verification of the ratepayers in the low-income category have proven difficult. Lack of information and suitable protections to ensure residents and ratepayers are confident that their personal information and privacy will be protected. Individuals and families that participate in other state-sponsored assistance programs have been easy to identify; however, individuals and families that do not participate in these programs have been underserved. Generally, energy efficiency programs require participants to share in the costs of the energy efficiency upgrades. Generally, low-income residents are not required to pay these costs upfront, but as mentioned previously, identification of these households can be difficult. The result is that these energy efficiency upgrades are unlikely to take place, thus leaving significant untapped opportunities, and increasing the energy burden on those who need help the most.

Maryland
Energy
Administration

Maryland

CLEAN ENERGY AND RESILIENCE

MAY 2022

DEVELOPED BY
Maryland Energy Administration

Clean Energy and Resilience

Introduction

Increasing the presence of clean and sustainable energy generation in Maryland is critical to achieving the state's objectives. Maryland has been and remains a leader in accelerating the adoption of clean energy technologies, such as solar PV, biogas and biomass energy systems, wind turbines, energy storage systems, among many others. The RPS, which is established by §7-703 of the Public Utilities Article ("PUA") of the Annotated Code of Maryland, sets forth year-over-year targets for percentages of electricity sales to retail electricity customers in the state to be from qualified renewable energy sources located in the PJM region and states adjacent to PJM. The Maryland RPS program's qualified resources are divided into two tiers, Tier 1 and Tier 2. Tier 1 resources include solar, wind, qualifying biomass, methane from a landfill or wastewater treatment plant, geothermal, ocean, small hydroelectric power, poultry litter-to-energy, waste-to-energy, and processed refuse fuel. Within Tier 1, there are also RPS "carve-outs" for solar, offshore wind, and beginning in 2023, geothermal. Tier 2, while being excluded for one year, will be returning with new legislation passed in the 2021 legislative session.[147]

Energy is deregulated in Maryland, which means that utility companies cannot be vertically integrated (i.e., the same entity cannot own generation, transmission, and distribution). Instead, utilities must purchase electricity from third-party suppliers, including Maryland homeowners and businesses that install qualified renewable energy systems on their homes and facilities interconnected with the electricity grid. Since these entities are both customers and generators, they are commonly referred to as "customer-generators." Any excess electricity produced by customer-generators is fed into the electricity grid. The customers receive credit for this production, which is netted against their electricity consumption. This process is called net metering. In this way, the state's net metering policy helps to encourage the deployment of renewables by providing financial value for qualified electricity production supplied to the grid. System sizes for net metering are limited to no more than 200% of the customer's baseline annual electricity use.

Although a significant adoption of clean energy technologies has been achieved, meeting the increasing RPS goals requires the continued and significant growth in implementation of qualified systems. This subsection details the current state of Maryland's clean energy industry and the hurdles that must be overcome to achieve RPS goals. It outlines ways to incentivize the adoption of clean energy technologies that drive the market, provide jobs, and assists in meeting Maryland's climate goals. It also provides recommendations to improve access to clean energy technologies to socioeconomically vulnerable, underserved, and unserved Maryland populations.

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[147] As defined by §7-701 of the PUA.

Current State Initiatives

There is a broad array of incentives available to Marylanders to encourage the adoption of clean energy technologies. MEA is at the forefront of this effort by offering grants, loans, and rebates for clean energy and energy-efficient technologies across many sectors of the state's economy. Current program offerings incentivize eligible geothermal, biomass, combined heat and power, energy resiliency, offshore wind, and solar projects -- including community solar, where participants can subscribe to participate in the benefits of solar via a project constructed locally within their electric service territory. More information on these programs can be found in *Appendix D: Existing MEA Programs- Clean Energy and Resiliency*.

Recent Technology and Policy Trends

Solar Energy

The overall solar market in the United States has been growing, but some significant short-term disruptions occurred in certain areas of the market. The COVID-19 pandemic appeared to have minimal effect on the commercial and industrial-scale solar markets. However, it did make zoning, permitting, and inspections more difficult in the first few months of the pandemic. The industry will have many areas of concern as the pandemic subsides, including the number of installers that remain in business, residential and commercial spending impacts, and any solar equipment delays resulting from supply chain issues.

Even without the backdrop of a pandemic, it is not easy to project the solar market in Maryland. The solar industry in Maryland became noticeable around 2010, with growth trends identifiable starting in 2012. Unfortunately, there was insufficient time to develop a stable trend before significant monetary influences began to affect the market. The years 2015-2017 showed a substantial surge in solar installations, particularly residential. The likely cause of this surge was federal consideration to reduce the 30% investment tax credit (ITC), reductions in solar equipment and development costs, the development of the state's net metering laws, and a highly favorable Solar Renewable Energy Credit (SREC) market. The ITC was ultimately extended at 30% until 2019, driving solar installations. Solar installations eventually exceeded Maryland's RPS requirements, causing prices in the SREC market to drop rapidly from around $100 in January 2016 to $5 in July 2016. Solar installations already under contract at that time tended to be completed, but residential and commercial markets rapidly contracted. Industrial installations were minimal and under long-term plans. However, economies of scale made these large projects less vulnerable to SREC price volatility. Implementation of community solar systems began to increase with the 2017 introduction of the Community Solar Pilot Program. These projects began to come online in 2018. As such, industrial-scale projects showed a relatively consistent increasing trend over time.

Industrial-scale solar projects tend to be designed, but about 75% of these projects initially registered in the PJM project interconnection queue are never built. The PJM review process for interconnection takes slightly longer than a year to complete absent issues that cause delays. Realistically the review process often takes two or more years. Similarly, Maryland's CPCN process, which applies to solar projects producing more than 2 Megawatts-ac of electrical power, or land-based wind projects greater than 70 Megawatts-ac can also be completed in about a year without concerns or problems. There are insufficient projects in the CPCN queue to meet the Maryland RPS requirements as of early 2021. The Recommendations section includes possible approaches to increasing deployment of industrial-scale solar projects from the Renewable Energy and Development Siting Task Force report completed in 2020.

More broadly, solar technology continues to improve in both efficiency and application, and costs have decreased. New developments in solar include bifacial solar modules, new materials such as perovskite[148] that may improve module efficiencies in the long term and lower cost in the near term, and improved building-integrated PV in the form of windows and building treatments.

The value of solar is a topic of multiple considerations that is largely still under development. Many components of the value stack are easy to identify, attribute, and value to the ratepayer, but other values such as health improvements accrue to the general public and not just the ratepayer. Further analysis and deliberation on how system owners are compensated for the value of solar are needed to ensure accurate consideration during Net Energy Metering (NEM) tariff discussions.

The siting of large solar arrays remains a topic of controversial discussion. Some individuals consider solar arrays to be visually appealing while others consider them unappealing. There is objection to placement of solar arrays on land previously used for agriculture because a concentration of solar arrays could undermine the critical infrastructure needed to sustain existing agricultural operations in the area. There is a desire for ensuring that existing farmland converted to solar projects can be reconverted back to farmland when the solar arrays are removed. The ability to do so is impacted by local tax considerations and some federal and state laws concerning locations such as wetlands, etc. Local planning and zoning boards and the PSC must consider these and many other concerns when determining whether to authorize a large-scale solar project. In early 2021, the PSC revised its CPCN regulations for generating stations to provide greater transparency into the determination of when a CPCN application is complete as well as to improve local host jurisdiction engagement in the CPCN process. The PSC undertook the rulemaking to help mitigate conflicts that can arise between solar developers and host jurisdictions and further streamline the CPCN review process.

[148] Read more about perovskite solar cells from the U.S. Department of Energy here: https://www.energy.gov/eere/solar/perovskite-solar-cells

Wind

The Maryland wind industry has largely shifted focus to offshore wind (OSW) solutions. This is because utility-scale OSW delivers the best value compared to smaller, land-based consumer systems at this time. Optimal land siting for wind is very limited in the state due to geographical constraints, and the average land-based wind speeds across Maryland are only about four meters per second (m/s).[149] Small projects, which are generally less than 100 kW in capacity, are prohibitively expensive because distributed wind costs have not fallen as quickly as those of utility-scale wind or consumer solar PV technologies. High consumer costs paired with low wind speeds, which can affect turbine production and operational costs, do not yield an economically favorable climate for smaller-scale, land-based wind. Conversely, OSW technologies can deliver a much better value to Maryland. Costs for utility-scale OSW have fallen significantly over the past decade, and offshore average wind speeds generally range from 8 to 9 m/s.[150]

The only land-based, utility-scale wind project in development in Maryland is Dan's Mountain Wind Force, LLC's 70 MW project in Allegany County. The project has received approval from the PSC. It is likely to be constructed within two years, pending any delays resulting from legal challenges and the COVID-19 pandemic.

Both of Maryland's OSW projects are still in the permitting phase and have submitted their Site Assessment Plans (SAP) and Constructions and Operations Plan (COP) to the U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM). As of spring 2021, the Construction and Operations Date (COD) for Ørsted's Skipjack Wind Farm (phase 1 and 2) is Summer 2026. The COD for US Wind's Maryland Offshore Wind Farm Phase 1 is December 2024 while Phase 2 is December 2026.

OSW development also offers considerable economic benefits to Maryland, such as job creation, supported by a local offshore wind business supply chain. In October 2020, Maryland joined the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER), a regional agreement with Virginia and North Carolina. This regional partnership allows the participating states to collectively promote offshore wind resources and development to attract offshore wind manufacturing and deployment.

Energy Storage

The development and deployment of energy storage is a critical component of the future energy grid. Energy storage is an enabling technology needed to help integrate increasing levels of intermittent renewable energy technologies. Energy storage can also help provide grid resiliency during power outages, allowing energy to be stored for critical services. Finally, energy storage enables markets to arbitrage energy. There are many types of energy storage systems, including,

[149] WINDExchange, DOE, windexchange.energy.gov/maps-data/325.
[150] Department of Energy, WINDExchange, windexchange.energy.gov/maps-data/180.

but not limited to lithium-ion batteries, thermal storage systems, hydroelectric pumped storage, flywheels, and compressed air systems.

Concurrent Energy Storage and Solar PV Installation

Many consumers install energy storage systems paired with renewable energy systems due to the convenience of a combined installation (as battery storage and PV systems can often be installed by the same company) and the incremental cost advantage of joint installation. If past trends continue, consumers are unlikely to install energy storage without installing solar PV systems beforehand or concurrently due to how energy storage is marketed.[151]

Energy Storage as a Cost Management Tool

Maryland's energy industry markets energy storage as a way to maximize renewable energy production, especially solar, via energy arbitrage. Energy storage allows consumers to mitigate the intermittency of renewable energy production by storing energy generated during peak production hours and then dispatch the stored energy when solar production does not meet demand, such as after dusk or during inclement weather. Consumers can also control costs by using stored energy rather than consuming grid energy at certain times, such as during more expensive peak demand hours. Both methods result in cost savings through a reduction of utility-produced energy consumption.

Utility-scale battery storage provides additional cost benefits by providing a multitude of grid services, ranging from: frequency regulation, voltage support, black start on the transmission system and on the distribution system, the alleviation of system constraints, and the provision of backup power. This technology will provide the opportunity for system upgrade and expansion deferrals throughout the grid, and in some cases negate the need entirely. The ability of these systems to increase profitability from wholesale market transactions can reduce consumer costs if at least a portion of those profits is remitted back to ratepayers.

Managing Disposal of Battery Systems

Batteries are one of the most widely deployed energy storage technologies. With this in mind, battery recycling options must be considered in the future. Lithium-ion batteries currently represent a large portion of the energy storage market; however, some energy storage systems are lead-acid batteries. A cost-effective collection and recycling pathway already exists for lead-acid batteries, which are recycled at a rate of nearly 100%. A similar path needs to be developed for lithium-ion batteries at the end of their useful lives in the U.S. More than 90% of lithium-ion battery materials (e.g., metals, electrolytes, etc.) are recoverable, yet the estimated U.S. recycling rate of these materials is only about 5%.[152]

[151] Solar and storage are typically marketed together.

[152] Department of Energy, Vehicle Technologies Office's Research Plan to Reduce, Recycle, and Recover Critical Materials in Lithium-Ion Batteries, 2019, energy.gov/sites/prod/files/2019/07/f64/112306-battery-recycling-brochure-June-2019%202-web150.pdf.

Roadblocks to recycling include economic constraints, logistical concerns, and lack of consumer education regarding the recyclability of batteries. Recycling battery materials extends their lifecycle, helps decrease the manufacturing costs of new battery production, and avoids environmentally detrimental disposal methods. State-level efforts may be complemented by federal initiatives such as the U.S. DOE Lithium-Ion Battery Recycling Prize,[153] an incentive designed to help fast-track innovative recycling solutions.

Maryland Energy Storage Pilot Program

In 2019, the PSC solicited two battery energy storage system (BESS) proposals from each of the four IOUs, BGE, PEPCO, DPL, and Potomac Edison. Each set of proposals was to be owned and operated under two of four possible frameworks: utility-owned and operated, utility-owned and third-party operated, third-party owned and operated, and virtual power plant (VPP), discussed in detail in the paragraph below). The PSC received all eight proposals in April 2020, and six of the eight proposals were approved (subject to modification) in November 2020. The approved proposals satisfy all four ownership models and are expected to generate valuable data and experience that will help shape the future of the utility-scale energy storage landscape in Maryland.

Virtual Power Plant Model

The virtual power plant (VPP) model is of particular interest among the four permissible PSC frameworks. A VPP is formed by purchasing and installing behind-the-meter energy storage systems in multiple locations, then networking them together to connect multiple DERs as an aggregated capacity source. During emergencies, VPPs can provide peak shaving and increased resilience for multiple properties at once. VPPs may be considered a more advanced form of demand-side management because they can combine generation and demand response, but determining the VPP controls and optimization to provide both best value and peak performance (via time-of-use rates, etc.) can be complex. Also, management systems need to have strong cybersecurity measures to avoid being tampered with or manipulated by external parties.

Existing Utility-Scale Energy Storage Systems

Existing storage systems in Maryland include BGE's Cold Spring Substation battery energy storage system (BESS) and the Warrior Run BESS in Cumberland. The Cold Spring Substation BESS was energized in March 2018 to help meet peak demand during the summer months. This system has allowed the utility to defer a new substation's costs while learning more about grid-scale battery storage units and how they can best support overarching utility goals. The 10 MW Warrior Run energy storage system is co-located with a coal-fired power plant and was energized in 2015. It remains the largest grid-scale energy storage project in Maryland and is used primarily for ancillary services such as "frequency regulation to the PJM market, reserves,

[153] Department of Energy, americanmadechallenges.org/batteryrecycling/.

renewable ramping, energy delivery and voltage control to increase the battery system's economic viability."[154]

Microgrids and Energy Resilience

Bolstering the resilience of energy infrastructure that provides power to Maryland residents, businesses, critical infrastructure, institutions, and many others is paramount as the grid faces an increasing number of threats to its integrity. These threats range from climate change impacts, weather events, lapsing cybersecurity, and aging grid infrastructure. Marylanders recognize these threats and seek solutions to prepare for, mitigate, and prevent their effects. Microgrids are an important part of the response.

Resilient Energy Systems with DERs

Maryland entities are responding to the many challenges facing grid integrity by installing behind-the-meter energy generation technologies, controllers, and management systems and energy efficiency upgrades that in some cases have grid-interactive capabilities. When strategically combined, they result in onsite energy management systems that allow customers to produce and store their energy, increase and decrease demand in response to grid conditions, and plan for extreme weather events and energy price fluctuations. This approach is being taken by many different entities in Maryland across all sectors of the state economy. For example, Maryland hospitals have implemented CHP systems that include the ability to restart after a grid outage event and provide electricity and thermal energy to critical facility loads. This trend is expected to continue into the near future. Awardees under MEA's Resilient Maryland program are planning microgrids and other resilient energy configurations that combine DERs such as solar PV technologies with battery storage and baseload CHP systems under advanced, predictive-logic controllers. They are also investing in energy efficiency upgrades to facility loads to reduce demand and make them more flexible to grid conditions.

These solutions have signaled a systemic drive across Maryland for grid integrity mitigation through targeted investment in bolstering onsite energy control and resilience. Businesses and residents that can produce and manage the majority or entirety of their energy generation behind-the-meter reduce their reliance on the grid's availability, which can help safeguard them against threats to life and safety and operational losses from sudden loss of grid power. Government entities are seeking energy resilience improvements to create safe locations with onsite power for communities during grid outages and emergencies. Manufacturers and agricultural entities are installing resilient and redundant energy systems to shield their product lines from downtime and destruction, and LMI multifamily housing communities are pursuing campus microgrids to meet sustainability goals and shield residents from the detrimental effects of power and thermal energy disruption. This trend in the growth of resilient energy projects is expected to continue.

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[154] Leading the Way: U.S. Electric Company Investment and Innovation in Energy Storage, *Edison Electric Institute*, October 2018.
eei.org/issuesandpolicy/Energy%20Storage/Energy_Storage_Case_Studies.pdf.

Challenges to Resiliency Projects

There are numerous challenges facing energy resilience as a whole and DERs in particular, which are vital components of energy resilience projects. For instance, the installation of DER systems has historically been challenging, although less so in recent years, for smaller-scale items like advanced CHP systems. There are three major hurdles that DER projects must overcome to move forward and become more marketable and therefore established in Maryland's clean energy economy:

Valuation and Split Incentives: Core to decisions related to resiliency is the value of these investments and to whom the benefits accrue compared to the investment or cost. Firming our understanding of the safety, economic, and social vulnerabilities concerning energy availability is essential to improving the business case for DERs that provide resiliency. A DER installed on a customer's site behind a meter enables the host to understand the costs vs. benefits to their application, including safety, lost revenue, preservation of critical services, etc. Many of these aspects are difficult to quantify but are qualitatively intuitive to those bearing the project's cost. Understanding the value of resiliency is more complicated when scaled up in the context of grid modernization as the benefits for one community, industry, or sector may be disconnected from the costs, which the overall rate base may bear. However, in many cases, a DER solution may substitute for a traditional expansion of capacity at equal or lower cost while providing a value-added "no wires solution." A more thorough dialogue on the sensitivities of costs and benefits, including equity and environmental justice considerations, is essential.

Conceptual Misunderstanding by Decision-makers

DER projects are large capital projects for the organizations that pursue them, and therefore the support of key decision-makers is critical to their success. These individuals are typically the most senior members of an organization's management team: presidents, chief executive officers, chief financial officers, chief operations officers, and facility managers, among others. These individuals hold the managerial authority of allocating time, effort, and organizational financial resources to moving DER projects out of the concept stage through design and eventual equipment procurement and installation. The value proposition of a DER system to the organization must be clearly defined in a manner that can be understood by decision-makers and persons in the organization who will implement placement and maintenance of the systems to secure this support.

Perceived Risk by Financiers

Energy capital projects are still perceived as somewhat risky by third-party capital providers, resulting from conceptual misunderstandings similar to those experienced by organizational decision-makers. Without a thorough understanding of the return on investment produced by a DER system over its lifecycle, it could be considered a risky investment vehicle by creditors and providers of equity, and any capital offered is priced accordingly. High financing charges erode project financials, which produce undesirable paybacks for organizations considering DER solutions. This risk could ultimately lead to the project's abandonment. Projects that include detailed life cycle financial analyses are much more likely to receive favorable financing terms because financiers clearly understand their expected return.

Statutory and Regulatory Barriers

Larger-scale DER systems, particularly community microgrids, will typically require crossing public right-of-ways to deliver energy produced from the point of generation to the facility loads. Current statutory laws and regulations in Maryland prohibit generators from installing distribution infrastructure across these right-of-ways, as doing so violates utility franchising rights. Presently, only local distribution companies are permitted to deliver energy from utility-scale generators to customers. Due to this barrier, community-scale, non-utility-owned microgrids or other DER systems that would include onsite generation systems, such as solar PV and CHP, are not possible. Existing statutes and regulations were enacted when DER systems remained significantly cost-prohibitive, and the technologies were not developed fully enough to be marketable. Thus, they are out of date and create a barrier that significantly hinders the DER market's progression in the state.

There are additional logistical barriers that must be overcome in utility infrastructure planning processes. The grid is a complex system of generation systems, transmission lines, transformers, distribution infrastructure, control systems, and other various components that has been planned and constructed over decades since commercially-available electricity was introduced. The microgrid and DER system models are relatively new concepts by comparison and will require utilities, policymakers, community planners, and other stakeholders in utility infrastructure planning to reformulate long-standing planning strategies to incorporate microgrids and DER systems. This reformulation will take time as these stakeholders complete engineering analyses, define risk profiles, complete capital planning, and design equitable tariffs, among many other logistical elements.

Grid-interactive Technologies and Resilience

The DOE's Building Technologies Office (BTO) introduced the concept of Grid Interactive Efficient Buildings (GEBs)[155] – proposing that buildings will operate dynamically with the grid to make electricity more reliable, cost-efficient, and better integrate DERs while meeting the baseline energy needs of building occupants. DOE sees this approach as a way of "integration and continuous optimization of DERs for the benefit of the buildings' owners, occupants, and

[155] DOE primer: Department of Energy, Office of Energy Efficiency and Renewable Energy, Grid-interactive Efficient Buildings, 2019, energy.gov/sites/prod/files/2019/04/f61/bto-geb_overview-4.15.19.pdf; See also: Rocky Mountain Institute, Grid-integrated Energy Efficient Buildings (GEBS), rmi.org/our-work/buildings/pathways-to-zero/grid-integrated-energy-efficient-buildings/.

the electric grid."[156] This task is performed through various measures designed to shed and shift load at key points in time and provide cleaner and more efficient infrastructure. Sometimes, this process is completed through simple but effective uses of technology, such as smart thermostats and smart appliances. In recent years, the functionality of thermostats has increased significantly. The technology has advanced from analog devices to advanced pieces of technology that incorporate building occupant behaviors that improve convenience, increase energy efficiency, and reduce overall heating and cooling costs.

Leveraging GEB to enhance energy resilience means making that resilience bidirectional, i.e., on the customer side of the meter and the utility grid side. Managing grid load conditions is no longer strictly confined to calling peaker plants online to supply additional electricity on peak demand days. Demand response has been a useful tool for grid operators and utilities to modulate customer load so that peaker generation is not required. This has helped to avoid high energy prices for consumers and GHG emissions from these plants. Grid-interactive technologies, such as smart HVAC systems, predictive logic controllers for DER systems, smart thermostats, and others, allow the automation of demand response services so that the grid and customer-side technologies can communicate with each other. This automation helps eliminate the risk of failed demand curtailment resulting from manual human operator error. Many Maryland entities have adopted these technologies in recent years, and they have become commonplace solutions in energy capital improvement projects that are incentivized by Maryland programs. This trend is expected to continue and additional technologies will be made grid-interactive. This will result in better optimization of energy balance between customer and utility, where energy is delivered at the lowest cost, and associated GHG emissions are minimized. Grid-interactive technology development and deployment will be critical in the long-term marketability of DER systems.

Federal Energy Regulatory Commission Order Rule 2222

FERC issued a ruling in 2020 that allows the participation of DERs in regional wholesale markets, including energy, capacity, and ancillary services markets.[157] DERs have historically been unable to participate in these markets outside of very limited methods - such as through demand response services. This challenge is simply because DERs are typically variable in nature and very small compared to traditional generators. The size of these units would not allow them to have an impact on system operations. However, with the increased use of technologies like battery storage systems and the newer ability of multiple DER systems to aggregate and act as a single larger unit, the capabilities of these systems have increased and will eventually be able to provide services to the grid. This attribute may also have a spillover effect of decreasing prices for households and businesses that are able to take advantage of aggregation and participation in these markets.

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[156] Ibid, 11.

[157] FERC, FERC Opens Wholesale Markets to Distributed Resources: Landmark Action Breaks Down Barriers to Emerging Technologies, Boosts Competition, ferc.gov/news-events/news/ferc-opens-wholesale-markets-distributed-resources-landmark-action-breaks-down.

Nuclear Power

Nuclear generating stations have been producing emissions-free electricity safely, for many decades, in the United States and abroad. Nuclear is recognized as one of the safest forms of power generation.[158] The industry presents a long history of proven safety,[159] and continually makes safety a top priority, building on decades of experience.[160] Additionally, recent probabilistic safety analyses demonstrate safety increases that are nearly tenfold compared to earlier designs.[161]

The state should retain and build nuclear power as part of Maryland's long-term clean energy portfolio by acknowledging the clean emissions profile of Calvert Cliffs (a potential template would be the formally introduced Clean and Renewable Energy Standard (CARES)) and by encouraging the growth of new, advanced generation nuclear designs, where feasible.

Some advanced designs are Small Modular Reactors. Some SMR's are based on light water technologies with passive safety features and are classified as Generation III+ designs. Others are more advanced designs with closed fuel cycles and are classified as Generation IV nuclear reactors.[162] These are among the most promising new nuclear technologies because they address the public's concern about long lived nuclear fuel waste. These reactors can also be an integrated part of a reliable baseload energy generation portfolio, contributing to a significant reduction in GHG emissions and supporting sustainable development. There are currently 72 SMRs under

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[158] Primer from the World Health Organization: Health consequences of Fukushima nuclear accident, 2016, who.int/news-room/q-a-detail/health-consequences-of-fukushima-nuclear-accident; Committee on Lessons Learned from the Fukushima Nuclear Accident for Improving Safety and Security of U.S. Nuclear Plants, Nuclear and Radiation Studies Board, Division on Earth and Life Studies, & National Research Council, (2014), *Lessons Learned from the Fukushima Nuclear Accident for Improving Safety of U.S. Nuclear Plants*, National Academies Press (US); Pushker A. Kharecha and James E. Hansen, *Environmental Science & Technology* 2013 47 (9), 4889-4895; Anil Markandya and Paul Wilkinson, Electricity Generation and Health, *The Lancet*, Volume 370, Issue 9591, (2007) 979-990.

[159] The IAEA has a good annual review of topical issues: International Atomic Energy Agency, Nuclear Safety Review, 2020, iaea.org/publications/reports; World Health Organization, Health risk assessment from the nuclear accident after the 2011 Great East Japan earthquake and tsunami, based on a preliminary dose estimation, 2013, who.int/publications/i/item/9789241505130; United Nations Scientific Committee on the Effects of Atomic Radiation, Developments Since The 2013 UNSCEAR Report On The Levels And Effects Of Radiation Exposure Due To The Nuclear Accident Following The Great East-japan Earthquake And Tsunami: A 2016 white paper to guide the Scientific Committee's future programme of work 2016, unscear.org/docs/publications/2016/UNSCEAR_WP_2016.pdf; International Atomic Energy Agency, The Fukushima Daiichi Accident, 2015, iaea.org/publications/10962/the-fukushima-daiichi-accident.

[160] Andrew Kadak and Toshihiro Matsuo, The nuclear industry's transition to risk-informed regulation and operation in the United States, *Reliability Engineering & System Safety* Volume 92, Issue 5, May 2007, Pages 609-618.

[161] Andrew Kadak, Columbia University Center on Global Energy Policy, A Comparison Of Advanced Nuclear Technologies, 2017, p 20, energypolicy.columbia.edu/sites/default/files/A%20Comparison%20of%20Nuclear%20Technologies%20033017.pdf

[162] For an overview of different nuclear technologies: Ibid.

development in 18 countries, including the United States. Other major developers include Canada,[163] China, and Russia, with wider deployment expected to begin this decade. Two reactor units of KLT-40S design are already in operation in Russia aboard the Akademik Lomonosov, a floating nuclear power plant. China's HTR-PM, a prototype SMR located in Shidao Bay, has just begun operation in 2022. This is an interesting addition since the reactor is cooled by helium and capable of reaching temperatures as high as 750 degrees Celsius, making it suitable for non-electric applications such as industrial heating and hydrogen production.

SMR's are projected to be less expensive than full-scale reactors once their mass production facilities are built,[164] and they require far less space. They can be as small as 2 MW up to 300 MW. Small and modular designs allow construction to better match load growth (as opposed to current nuclear units, which are built-in blocks of 1,000 to 2,000 MW). It can often take years for the load to grow and utilize all the available capacity. These units should also have better cost control, owing to their similar design and factory construction where quality control is easier to achieve. The smaller size may allow units to be used in remote locations without connecting to the larger electric grid and can be designed to be located underground for greater security and safety. New safety features, including passive shutdowns and cooling, are inherent in the design, meaning these safety mechanisms operate without the need for external power.

In the United States, companies like NuScale Power, headquartered in Oregon, are pushing ahead with SMR designs. The firm has designed a small modular reactor that would take up a fraction of the space required for a conventional reactor, which is especially attractive to states such as Maryland, with a relatively small geographic area. Not only are these systems smaller, but they can aggregate with other units and are far safer than previous iterations of nuclear reactors. These units have cutting-edge passive safety features,[165] including water-submerged containment vessels that maintain cooling even without electricity, the use of natural draft air for containment, and emergency operations such as the release of cold borated water over the control rods.[166] The U.S. Nuclear Regulatory Commission (NRC) licensed a leading SMR design in September 2020, and a demonstration pilot with several units of the licensed design is underway in Utah with a proposed total nameplate capacity of 462 MW. Usually, these reactors

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[163] In December 2020 the Canadian government officially launched their SMR Action Plan: Canada Outlines Next Steps for Progress on Small Modular Reactor Technology, canada.ca/en/natural-resources-canada/news/2020/12/canada-outlines-next-steps-for-progress-on-small-modular-reactor-technology.html.

[164] SMRs are built in a factory and shipped to the installation location. This allows for better automation of welding and quality control, and allows for greater speed of production without reducing safety, reliability, or quality. All these factors drastically reduce costs. The best estimates have SMRs at roughly $3,500/kw as compared to nuclear at $6,000+/kw. See: Geoffrey A. Black, Fatih Aydogan, Cassandra L. Koerner, Economic viability of light water small modular nuclear reactors: General methodology and vendor data, *Renewable and Sustainable Energy Reviews*, 103, 2019, 248-258.

[165] "Passive" here refers to these safety mechanisms typically engaging automatically without human intervention or requiring the use of energy to operate.

[166] For an overview of some of these passive safety features: International Atomic Energy Agency, Passive Safety Systems in Water Cooled Reactors: An Overview and Demonstration with Basic Principle Simulators, Training Course Series 69, www-pub.iaea.org/MTCD/Publications/PDF/TCS-69web.pdf.

are as small as 60 MW and are generally grouped by 4, 6, 8, or 12 reactors per site. This scale is flexible and contingent on local demand and requirements. Since the scale of development is flexible, SMRs provide policymakers and developers more financial flexibility as well. Furthermore, these systems can provide even more rapid, scalable dispatch of electricity, unlike the standard, first and second generation nuclear facilities in operation today in the United States, which essentially have to operate continuously with very limited load following capability. SMRs are more flexible than the large nuclear reactors and can also be used to supply base-load demand and a portion of the additional intermediate load demand. The steam processes associated with SMRs can even potentially provide a source of green hydrogen, although this is still in the early stages of development.[167]

It should also be noted that Maryland hosts the Nuclear Regulatory Commission (NRC), which has spurred the emergence of companies operating within the state that are working on advanced nuclear designs, such as X-energy. Given the state's unique position, leveraging relationships with Maryland-based entities such as the NRC and X-energy should be a priority. Expanded further in the recommendations section below, Maryland should seriously consider support for new nuclear-generating assets in the state, preferably in areas where a station could take advantage of existing transmission assets, reducing the need to site this additional equipment. Canada is demonstrating a potential model for use in the United States when it comes to nuclear power given its recent, strong push in this direction, generating an SMR action plan and roadmap for the country, along with accelerating firm investments in this technology.[168]

Hydropower

In-state hydroelectric power generation remains the largest share of renewable energy generation in the state, contributing roughly half of all renewable energy generated. Collectively, there were 2.188 million MWh of hydroelectricity contributed to the state's overall generation portfolio in 2019.[169] There are two hydroelectric plants in Maryland; and the largest is the Conowingo Hydroelectric Generating Station, built on the Susquehanna River nearly a century ago. This station provided over 98% of the state's hydroelectric power in 2019, with 530 MW of

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[167] Popular Mechanics, Tiny Nuclear Reactors Yield a Huge Amount of Clean Hydrogen, popularmechanics.com/science/energy/a34964936/small-modular-reactors-produce-clean-hydrogen/; NuScale Power, NuScale Power Releases Updated Evaluation for 77 MWe Module Clean Hydrogen Production, newsroom.nuscalepower.com/press-releases/news-details/2020/NuScale-Power-Releases-Updated-Evaluation-for-77-MWe-Module-Clean-Hydrogen-Production/default.aspx; Idaho National Laboratory, A Step Closer to Clean Hydrogen, March 5, 2021, inl.gov/article/a-step-closer-to-clean-hydrogen/.

[168] Government of Canada, Canada's Small Modular Reactor Action Plan, nrcan.gc.ca/our-natural-resources/energy-sources-distribution/nuclear-energy-uranium/canadas-small-nuclear-reactor-action-plan/21183; Canadian Broadcasting Corporation, Federal government invests in small nuclear reactors to help it meet net-zero 2050 target, cbc.ca/news/politics/bains-small-modular-reactors-net-zero-1.5763762, October 15, 2020.

[169] Energy Information Administration, Data Electricity Browser, Maryland 2019 Net Generation Conventional Hydroelectric, eia.gov/electricity/data/browser/.

nameplate capacity.[170] The other plant is located in Deep Creek and runs with a 20 MW capacity.[171]

Small and micro hydro present an opportunity to address multiple needs in the state, including the ability to provide revenue to support aging, already developed infrastructure already embedded in many communities, improving the safety of potentially high hazard structures, resiliency, and in many cases, enhancing recreational opportunities. A recent National Renewable Energy Laboratory (NREL) report defines small hydro as approximately 10 MW.[172] Applications in Maryland may be considerably smaller. Continued monitoring of the appetite for investment and community interest of this resource may help open it up for future clean energy development.

[170] Ibid., Form EIA-860 survey data.
[171] Ibid.
[172] State Models to Incentivize and Streamline Small Hydropower.

Maryland
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Administration

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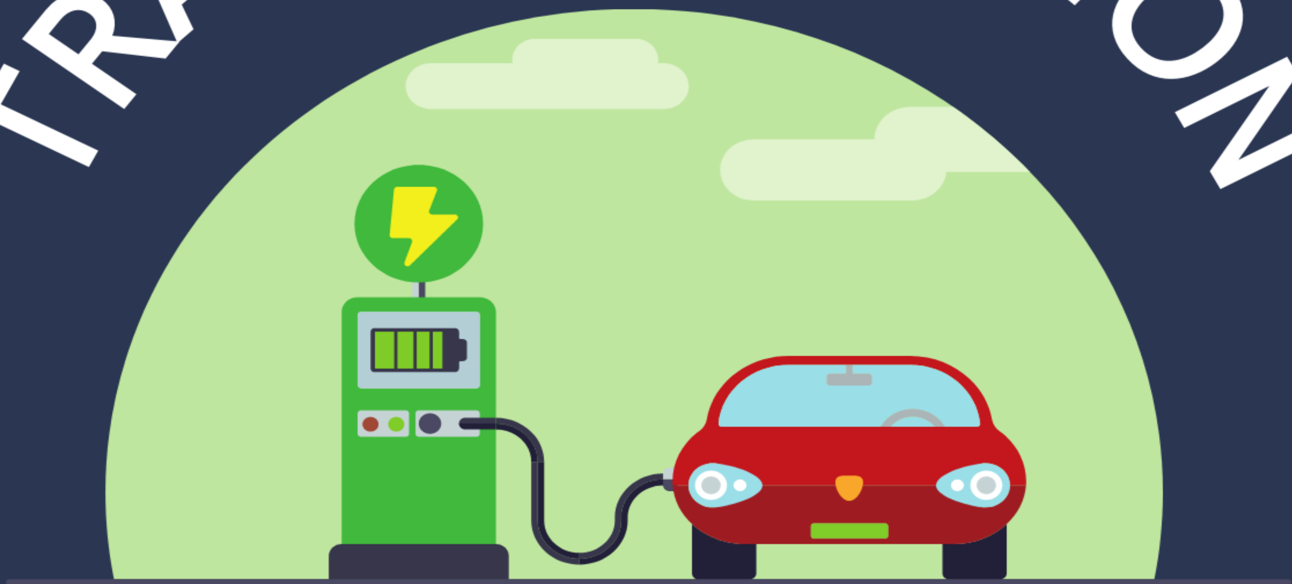
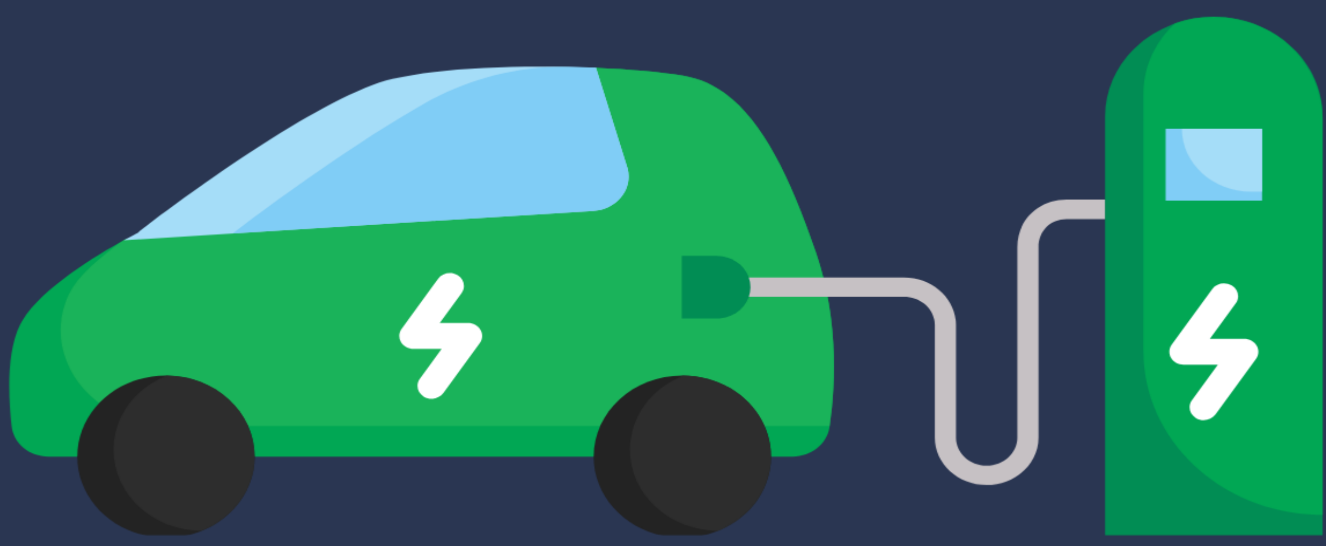
TRANSPORTATION





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Maryland Energy Administration

Transportation

Introduction

Maryland is committed to encouraging the use of clean transportation. Increasing the deployment of zero-emission vehicles (ZEVs) and their associated infrastructure is a key element to meeting the state's clean energy goals. In 2018, the transportation sector accounted for about $9.3 billion in fuel costs (expenditures by vehicle owners) annually.[173] It also accounted for 47.7% of GHG emissions in Maryland.[174] Under the reauthorized GGRA, the state is committed to reducing GHG emissions by 40% from 2006 levels by 2030. Given the proportion of GHG emissions from transportation, this sector's transformation will play a key role in attaining the GGRA goal.

An estimated 59.8 million vehicle miles were traveled within Maryland in 2018,[175] and electric vehicles (EVs) increasingly contribute to this number. EVs are a subset of ZEVs, with ZEVs including hydrogen-fueled vehicles that, similar to EVs, have no tail-pipe GHG emissions. As of February 2021, there are more than 30,000 EV-type vehicles in Maryland.[176] This number is far short of the state's target of 300,000 ZEVs registered by 2025 as established in a multi-state ZEV memorandum of understanding (MOU) signed by 10 states.[177] This multi-state MOU commits to cumulatively having at least 3.3 million ZEVs by 2025. The figure below shows the growth of registered EVs in Maryland to date (up to February 2021):

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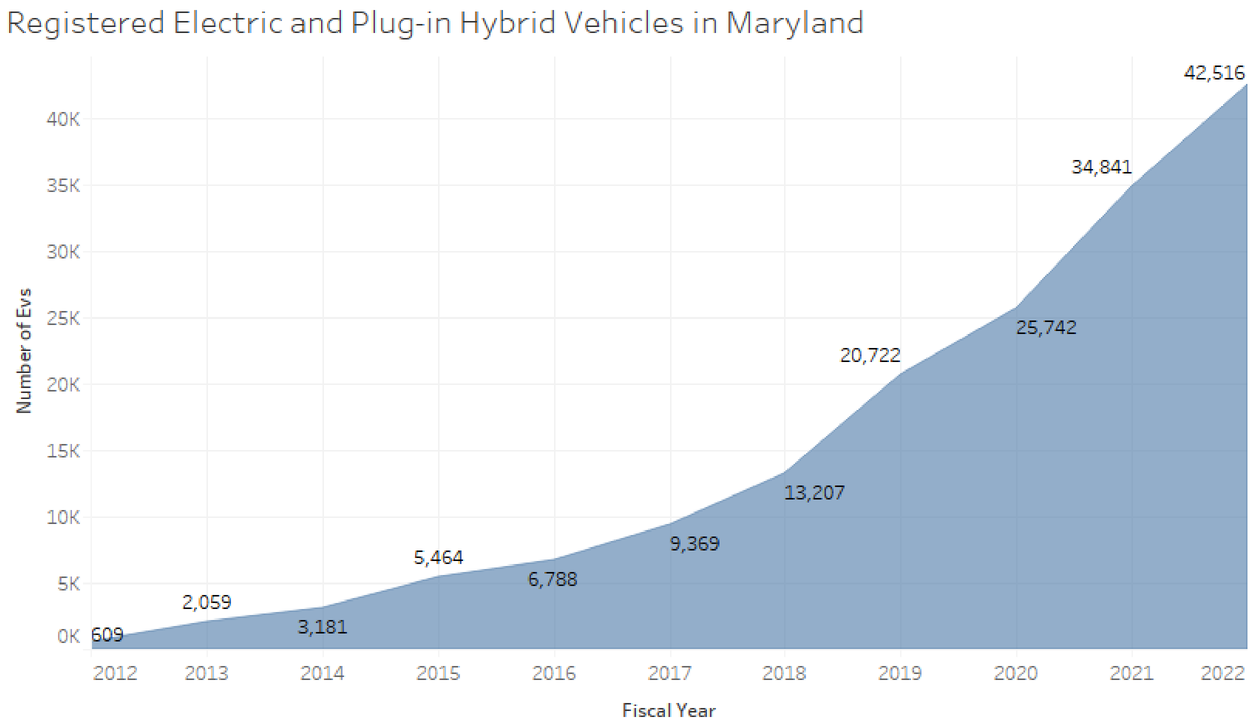
[173] EIA 2020, State Energy Data System (SEDS): 1960-2018 (complete), Table E6. Transportation Sector Energy Price Estimates, 2018, eia.gov/state/seds/data.php?incfile=/state/seds/sep_sum/html/sum_pr_tra.html&sid=MD

[174] EIA 2021, Energy-Related CO2 Emission Data Tables, Table 4. 2018 State energy-related carbon dioxide emissions by sector.

[175] U.S. Department of Transportation: Federal Highway Administration. 2019. Highway Statistics 2018: Functional System Travel- 2018 Annual Vehicle - Miles, Table VM-2. fhwa.dot.gov/policyinformation/statistics/2018/vm2.cfm

[176] MDOT/MVA Electric and Plug-in Hybrid Vehicle Registrations by County, opendata.maryland.gov/Transportation/MDOT-MVA-Electric-and-Plug-in-Hybrid-Vehicle-Regis/qtcv-n3tc/data,

[177] MDE, Zero Emission Vehicles, mde.maryland.gov/programs/air/mobilesources/pages/zev.aspx



Source: MEA generated graph with data from MDOT. * Data up to January 2022.

As EV capacity grows, it poses challenges and opportunities to the grid and could increase the need for grid upgrades to support electricity demand growth. The impact of EVs on the grid can be influenced by the time of day when EVs are charging, the number of EVs on the road or EV adoption rate, and grid capacity. Areas with higher concentrations of EVs are more likely to face higher grid stress from increased EV charging.

Maryland has adopted several measures to reduce barriers, promote ZEV adoption, and reduce grid impacts of EV adoption. This subsection details the current state of transportation-related energy initiatives in Maryland, the challenges facing the transportation system and ZEV adoption, and recommendations for promoting ZEV adoption for all Marylanders' benefit.

Current State Transportation Programs and Initiatives

There are several programs and initiatives offered in Maryland that support the state's energy-related transportation goals.

State Programs

MEA offers incentive programs for EV charging infrastructure and programs focused on expanding fleets that use fuel infrastructure to deliver lower carbon fuels. Additionally, the state is a beneficiary of the Volkswagen Diesel Emissions Environmental Mitigation Trust, resulting from an emissions-related cheating scheme that occurred a few years ago, to implement several energy-related programs aimed at reducing NOx in transportation. More information on state-implemented transportation-related programs can be found in Appendix E of this report.

Public Service Commission Programs

The PSC regulates public utilities in Maryland. The PSC initiated Public Conference (PC) 44 proceeding to enhance Maryland's electric grid's affordability, reliability, and environmental sustainability. The PC44 EV workgroup began in 2018, and has worked to remove the barriers associated with EV deployment, increase the electricity distribution system's reliability, and lower electricity demand at peak periods. In January 2019, the PSC issued Order 88997 establishing an EV charging pilot for utilities BGE, PHI, and Potomac Edison to offer rebates and create residential, multi-family, and public EV charging programs for five years. Four hundred and fifty-three rebates were awarded in 2020, totaling $251,456, and 73 Level 2 and 15 DC fast EV Supply Equipment (EVSE) were installed by the utilities.[178] These programs are designed to help customers understand EV charging loads, and collect data and information on EV charging patterns and grid impacts.

BGE, PEPCO, and Delmarva launched their incentive program in July 2019 for residential and multi-family homes. In 2020, BGE awarded 308 rebates, totaling $199,856, and installed a total of 64 EVSE (50 level 2 and 14 DC). PHI awarded 117 rebates, totaling $43,500, and installed 18 EVSE (17 Level 2 and 1 DC). Potomac Edison launched its incentive program in December 2019 and awarded 27 rebates, totaling $8,100, and installed five level 2 EVSE in 2020. SMECO installed one level 2 EVSE in 2020. [179]

On October 13,2021, the PSC conducted a legislative-style hearing to review the progress to date of the statewide EV Portfolio, known as the mid-course review. BGE, the PHI utilities, PE and SMECO presented their respective mid-course proposals, and several other participants offered comments.

Transportation Collaborations

Maryland has a statutorily-established Zero-Emission and Electric Vehicle Infrastructure Council (ZEEVIC) to develop policies and incentives to promote the adoption of ZEVs, raise awareness for ZEVs, and facilitate the integration of ZEVs into Maryland's transportation network. Additionally, Governor Hogan, along with 14 other state governors and the Mayor of Washington D.C., signed a Memorandum of Understanding (MOU) to voluntarily work collaboratively to promote the market for electric medium and heavy-duty (MHD) ZEVs within their jurisdictions. Finally, Maryland is a member of the Northeast States Coordinated Air Use Management (NESCAUM) Multi-State ZEV Task Force, enabling nine states to coordinate action to support the successful implementation of state ZEV programs. Additional information on these collaborative efforts can be found in Appendix E.

[178] ZEEVIC Report mdot.maryland.gov/OPCP/Final_ZEEVIC_2020_Report.pdf
[179] Ibid

Electric Vehicle Supply Equipment (EVSE) Rebate Program
The EVSE rebate program seeks to reduce the financial burden of installing charging infrastructure for EVs. This effort is a critical component of advancing the deployment of EVs in the state. It improves EV owners' ability to charge in the two key places owners typically charge their vehicles: at home and work. Between FY15 and FY21, Maryland issued rebates for 5,540 chargers (both residential and commercial).

Added In-State Benefits to Electric Vehicle Owners
Ancillary benefits to EV owners can often serve to help nudge potential buyers toward a purchase. There are several such benefits in Maryland:

- Permitted EVs registered in Maryland can operate in high-occupancy vehicle (HOV) lanes regardless of occupant number. This exemption applies only to EVs with a maximum speed capability of at least 65 miles per hour. The exemption expires on September 30, 2022.
- ZEV owners in the State of Maryland are also exempt from mandatory tests and inspections. This benefit results in substantial personal savings to EV owners over the vehicle's life and requires no further expenditures on the part of the state.

Efficient Public Transportation
Developing an efficient public transportation system in Maryland is critical for driving transportation development and energy savings. Under the GGRA, Maryland has a target for its bus fleet to be 50% zero-emission by 2030. The state has also promoted the development of electricity-powered light rail transportation. Governor Larry Hogan approved the construction of a 16-mile metro line (part of the broader metro network of the District of Columbia), called the Purple Line, that will extend from Bethesda in Montgomery County to New Carrollton in Prince George's County. The Purple Line is owned by the Maryland Department of Transportation (MDOT) Maryland Transit Administration. A private-sector partner, Purple Line Transit Partners (PLTP), would design, build, operate, and maintain the system for 35 years. This project will expand electrified transport throughout the region further.

Zero-Emission Vehicles (ZEV) Tax Credit Program
Maryland offered an excise tax credit of up to $3,000 for EVs with a purchase price below $60,000 before funds were exhausted. The program was implemented by the Maryland Motor Vehicle Administration (MVA), with funds from the SEIF and the Transportation Trust Fund.

Alternative Fuels
Identifying lower carbon alternatives in the transportation sector is vital to meeting the state's GHG emission goals. The Clean Fuels Incentive Program (CFIP) is designed to promote alternative fuels in Maryland's transportation sector. The program provides funding for alternative fuel vehicles such as electric, natural gas, propane, biodiesel, and hydrogen vehicles. The program is part of the state's overall goal of promoting cleaner and greener transportation while boosting the local economy and preserving the environment. Applicants must be fleet

vehicle purchasers or vehicle operators, such as school districts, municipal authorities, local governments, and corporations.

Alternative Fuel Corridors

Alternative fuel corridors (AFCs) are another approach to driving the growth of the marketplace. These programs enhance drivers' ability to transit regionally and nationally with cleaner fuels by providing access to these fuels and reducing range anxiety. Further, these programs can typically be co-opted into existing state planning programs. In 2016, MDOT, in coordination with MDE, MEA, and the Maryland Clean Cities Coalition, submitted a nomination to the Federal Highway Administration (FHWA) and U.S. Department of Transportation (DOT) solicitation for alternative fuel corridors under the Fixing America's Surface Transportation (FAST) Act, and was selected for the alternative fuel corridor designation. As of August 2021, Maryland has 22 EV AFCs, one Compressed Natural Gas (CNG) AFC, one liquified natural gas (LNG) AFC, and two liquefied petroleum gas (LPG) AFCs.[180] There are more than 900 publicly available charging stations with more than 2,400 charging outlets.[181]

Bimbo Bakeries USA partnered with MEA to green their fleet of delivery vehicles fueled by emissions-reducing, domestically produced propane Autogas in 2016. The grant enabled the bakery to replacement of 45 vehicles displaced approximately 190,000 gallons of petroleum annually.

Finally, the DOE Clean Cities Program promotes clean AFVs and fueling infrastructure through public-private partnerships. The program utilizes a voluntary approach to AFV development, working with local stakeholders' coalitions to support the industry. MEA is the coordinating agency for the Maryland Clean Cities Coalition.

Clean Fuels Technical Assistance Program (CFTA-MEA)

The CFTA is a new pilot program administered by MEA.[182] Through the CFTA, a technical assistance contractor provided by MEA is tasked to work directly with eligible local government fleets, selected via an application process to develop potential alternative fuel fleet strategies for on-road vehicles. Each approved technical assistance project results in a final report identifying potential fueling options and strategies based on technical and economic considerations specific to the applicant's circumstances, vehicle needs, and operating profiles. These reports, including

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[180] MDOT Corridors website:mdot.maryland.gov/tso/pages/Index.aspx?PageId=167
[181] Department of Energy, Alternative Fuels Data Center, afdc.energy.gov/publications/search/keyword/?q=electric%20vehicle.
[182] Clean Fuels Technical Assistance Program energy.maryland.gov/transportation/Pages/Clean-Fuels-Technical-Assistance-(CFTA)-Program.aspx

those for Baltimore City, Cumberland, Laurel, and Rockville, are publicly available on MEA's [CFTA program website](). So far, MEA has provided assistance to five local governments. MEA anticipates expanding this kind of assistance to address a variety of local government fleet needs.

Governor Larry Hogan's efforts to promote the Clean Cars Act of 2019 included an exhibition of hydrogen cars in Annapolis from the Association of Global Automakers, Hyundai Motor Company, and Toyota Motor Corporation.

State Fleet Purchases

Some state agencies, including MEA, the Department of Budget and Management (DBM), and DGS, work collaboratively to develop state fleet EV plans and goals. Funding from the SEIF assisted state fleet EV purchases, starting in FY20. Forty EVs have been ordered with FY21 funding as of June 2021. Those vehicles will be deployed to eight agencies and across nine sites, and are scheduled to arrive by September-October 2021.

The FY22 budget bill (HB 588, Section 40) requires at least 25% of state fleet passenger vehicles purchased in FY22 to be ZEVs, meaning approximately 50 ZEVs will need to be ordered in FY22. MEA will coordinate with DBM and DGS to plan these vehicle deployments in tandem with supporting infrastructure, which in FY22 will be largely funded by $1 million in funds in DGS's approved FY22 budget.

Volkswagen Settlement

The Volkswagen emissions scandal involved Volkswagen cheating on vehicle emissions testing. As a result of the scandal, the company incurred significant financial penalties, much of which was distributed abroad. Maryland is a recipient of some of these funds, and multiple agencies have worked to develop a thorough plan for fund uses.

Within Maryland, the Volkswagen EV Infrastructure Program was funded as a result of that settlement. This program utilizes 15% of the Volkswagen Mitigation Funds available to Maryland to help facilitate EV charging infrastructure at state-owned facilities, workplaces, and alternative fuel corridors.[183] MEA, along with MDE, has developed two frameworks for proposals under this program. The first is the Maryland Charge Ahead Grant Program (CAGP), which distributes funds for charging infrastructure at state-owned facilities and workplaces. The second is the Maryland Electric Corridors Grant Program (ECGP), which provides funding for

[183] The Volkswagen Mitigation Fund is a settlement agreement of about $2.7 billion which was to be used by states to remediate the excess NOx emissions from Volkwagen's Clean Air Act violation. Maryland is a beneficiary of the settlement and is eligible to receive approximately $75.7 million; Maryland Volkswagen Mitigation Plan, 2019, mde.maryland.gov/programs/Air/MobileSources/Documents/Maryland-Volkswagen-Mitigation-Plan.pdf.

DC Fast Charging along alternative fuel corridors and at charging hubs to facilitate interstate and intrastate travel.

The plan also directs funding to the following recipients:

- Private business and federal government
- Local governments and communities, with communities that bear a disproportionate share of the air pollution burden being given special consideration. A portion of the funds will be set aside specifically for transit bus and school bus replacements
- State agency projects
- Administrative costs to oversee the fund use

Transportation Infrastructure and Resilience

As the diversity of fuels being used to support transportation grows, the dynamics of ensuring that infrastructure is available that can provide both cleaner and resilient fuels are essential. As electric and zero-emissions technologies become more widely adopted, bolstering the ability of these systems to function during an electricity outage is essential. MEA is working with stakeholders to expand the number of charging stations, particularly along key corridors, including evacuation routes. More publicly available chargers increase the likelihood that many chargers will be available to support the mobility of light and heavy-duty fleets.

In addition, MEA is working with local governments and others to combine technologies to develop charging infrastructure to support public fleets, including transit. Leveraging a $300,000 grant from MEA's Public Facility Solar Program, Montgomery County is developing the "Brookville Smart Energy Depot;" the groundbreaking for this facility occurred in September 2021. This unique asset will combine solar PV, energy storage enabled by the PC44 proceeding, natural gas generation, and advanced controllers to charge dozens of electric buses.[184] The project is financed by a unique public-private partnership (P3) enabled by a confluence of local leadership, state incentives and public policy changes that will ensure the county's transit fleet operates with cleaner electricity and provides options for continuity of service during a prolonged outage.

Recent Technology and Policy Trends

Market Outlook of EV

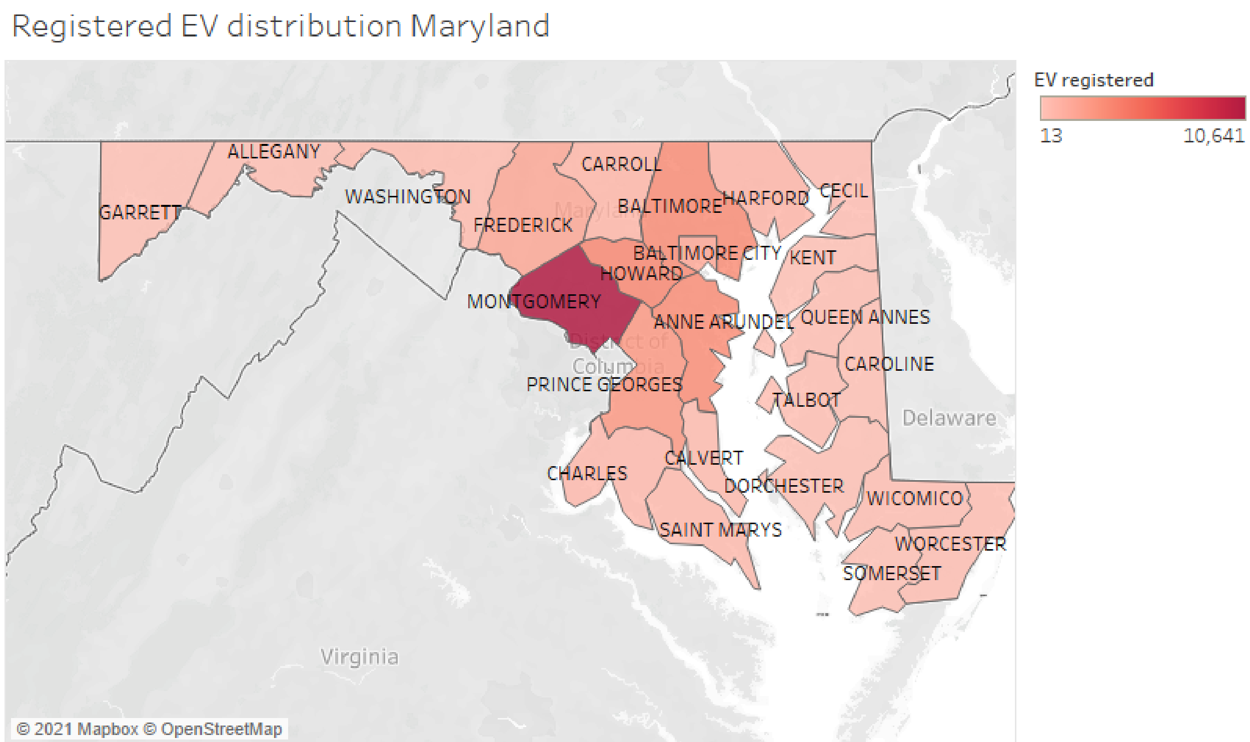
EVs have experienced significant growth in Maryland over the last few years. The number of registered EVs grew from 609 in 2012 to 30,345 in February 2021. As of February 2021, 60% of registered EVs are battery EVs (BEVs), while the others are plug-in hybrid EVs (PHEVs). The two types of EVs differ in that BEVs operate off a battery 100% of the time, while PHEVs have

[184] Montgomery County Brookville Smart Energy Depot Project, Mandatory Referal Public Meeting presentation montgomerycountymd.gov/dgs-oes/MGP-BrookvilleDepot.html

both a battery and a gasoline engine. Overall EV growth is supported by state and federal incentives, which decrease vehicle cost, and expanding infrastructure availability.

Growth in EV registration in Maryland has been concentrated in central Maryland, even though other parts of the state have also experienced some growth. As of February 2021, four counties in Maryland have at least 3,000 PEVs registered. Most PEV registrations are from Montgomery County, with over 10,000 PEV registered. The figure below shows the distribution of EVs in Maryland as of February 2021.

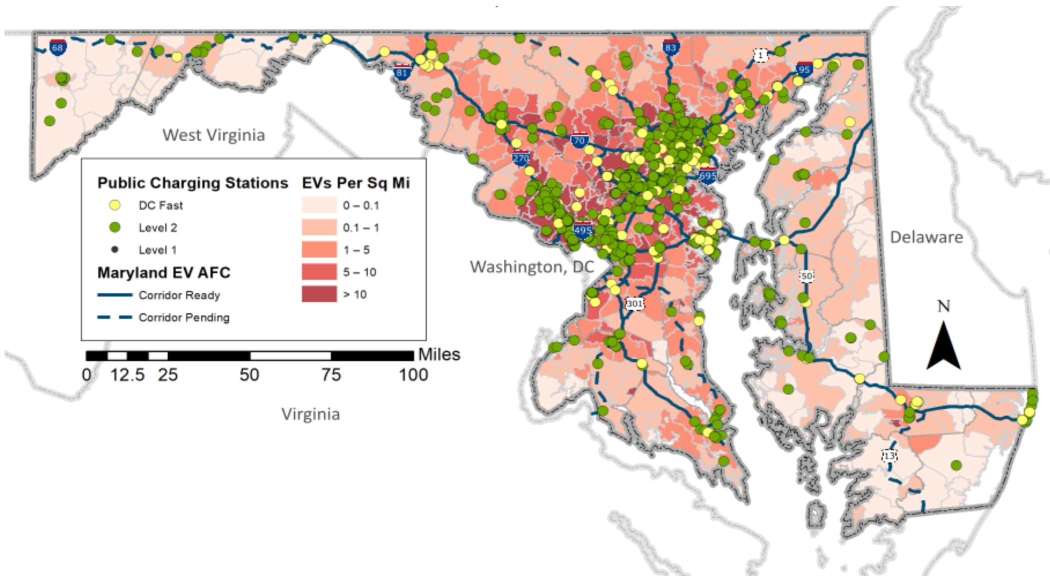
Distribution of Electric Vehicles in Maryland (February 2021)



There are also about 740 charging stations in Maryland with over 2,300 public outlets.[185] Maryland has a robust network of AFCs designated by FHWA. There are currently 21 EV AFCs in Maryland. The figure below shows the location of AFCs and types of public charging stations in Maryland.[186]

[185] Zero Emission Electric Vehicle Infrastructure Council, Annual Report 2020, retrieved from: mdot.maryland.gov/OPCP/Final_ZEEVIC_2020_Report.pdf
[186] MDOT, 2021, Alternative Fuel corridors, mdot.maryland.gov/tso/pages/Index.aspx?PageId=167

Charging stations in Maryland[187]



Hydrogen

Hydrogen can be used to power fuel cell EVs. There are about 8,000 fuel cell EVs (FCEV) in the United States, most of which are located in California. Consequently, the vast majority of public hydrogen fueling stations are also located in California. There are private hydrogen fleet stations built or planned in several states, including New York, Pennsylvania, and Connecticut. Hydrogen fuel cell vehicles currently on the market are limited in Maryland by the lack of fueling stations. Additionally, there is a desire for hydrogen fuel to be generated by renewable resources rather than the traditional method, which utilizes natural gas. The industry has expressed an interest in the Maryland region as well, and the ZEEVIC task force is tasked with aiding the growth in hydrogen fuel cell infrastructure, in addition to its role in the EV infrastructure.

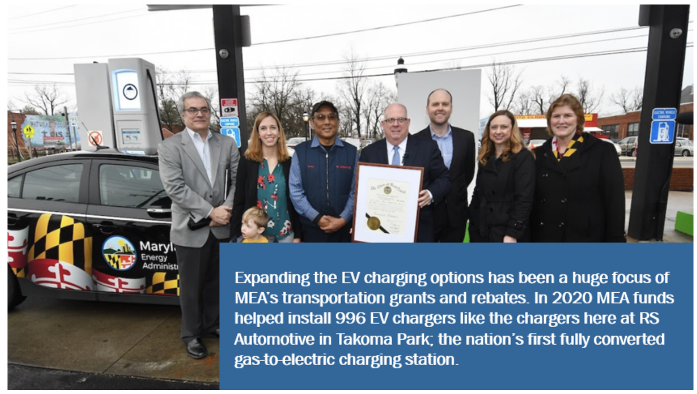
Plug-in Hybrid Electric Vehicles (PHEV)

Plug-in hybrid vehicles are often seen as transitional vehicles as we move toward a cleaner transportation future. However, studies suggest that PHEV emissions are only slightly lower than conventional vehicles over their lifetime.[188] In Europe, policymakers are considering new emission rules that could limit the market of PHEV. New regulations would not allow these vehicles to be considered sustainable investments and would create rules designed to limit nitrogen oxide emissions, potentially increasing the costs.[189] If these regulations are enacted, it

[187] Ibid
[188] Transport and Environment, 2020, UK briefing: The plug-in hybrid con, retrieved from transportenvironment.org/sites/te/files/publications/2020_09_UK_briefing_The_plug-in_hybrid_con.pdf, Plötz, P., Moll, C., Bieker, G., Mock, P., & Li, Y. (2020). REAL-WORLD USAGE OF PLUG-IN HYBRID ELECTRIC VEHICLES: FUEL CONSUMPTION, ELECTRIC DRIVING, AND CO2 EMISSIONS. Berlin: ICCT – International Council on Clean Transportation Europe.
[189] Carey, N., & Abnett, K. (2021). Once 'green' plug-in hybrid cars suddenly look like dinosaurs in Europe. Reuters.

could shift the perception of PHEV as bridges toward EV transition. This shift could also have implications for the United States and Maryland as the state moves towards its EV goals.

EV support of road infrastructure
Historically, drivers contribute to the creation and upkeep of roads through gas taxes; however, BEV drivers pay zero gas tax. With this in mind, some states have begun to consider how drivers of EVs can contribute to road maintenance.


Expanding the EV charging options has been a huge focus of MEA's transportation grants and rebates. In 2020 MEA funds helped install 996 EV chargers like the chargers here at RS Automotive in Takoma Park; the nation's first fully converted gas-to-electric charging station.

Options being considered nationally include registration fees for EVs, mileage-based user fees, and sub-metered charging fees that can accumulate revenue based specifically on the amount of kWh charged to an EV.

As many as 28 states have implemented additional registration fees for EVs in addition to standard registration fees. Additional EV fees are designed to make up for the lost gas tax revenue. Maryland currently does not have different registration fees for EVs and intends to wait until EV adoption rates are significant before considering such a measure. Read about the country's first fully converted gas-to-electric charging station in Takoma Park here.

Mileage-based user fees or road user charge is an alternative to the registration fees. Some states, such as Oregon and California, have introduced pilot programs to study the effects of mileage-based fees for vehicles.

Under any scenario, any financial contributions ultimately assessed to EV drivers for road infrastructure and maintenance should be carefully designed to be commensurate with EV drivers' road usage and not create barriers to adoption that would interfere with the state's ZEV goals.

Goals for Vehicle Miles Traveled
Some jurisdictions such as Boston, Minneapolis, and Columbus have implemented vehicle miles traveled (VMT) reduction goals by encouraging alternative transportation modes such as walking, cycling, and public transportation. Such goals could be a reasonable policy for Maryland to consider. In addition to GHG benefits, there could also be potential traffic reduction benefits. Post-COVID, there is likely to be an increase in remote work that would change commute patterns that could help make inroads into this type of goal.

Time of Use rates for EV charging
Time of Use (TOU) utility rates for EVs are designed to address changes to the electric grid caused by increased EV adoption. Electricity demand increases from EV adoption could place

more pressure on the grid. TOU rates are designed to create incentives for EV drivers to charge vehicles during off-peak hours. Utilities in Maryland, such as BGE, have introduced programs offering TOU rates for EV charging. Issues that arise are whether separate residential meters or smart charger embedded metrology would assist in TOU, or whether whole-home use would be included.

Incentives in support of state goals

Policy challenges local to Maryland include strained program funding for incentivizing EVs.The state will need to more seriously examine potential pathways for delivering incentives supporting state EV goals. By making programs more targeted and aimed at households that require incentives to make EVs affordable, there is an opportunity to improve the effectiveness of limited funds. A study of the efficacy of the different types of EV incentives in driving EV adoption would help the state prioritize the incentives that best support the state objectives. For instance, the most recent EV tax credit structure (FY18-Fy20) may not be affordable at current EV adoption rates. The adoption of more targeted and effective incentives would help advance the state's EV goals. The growth of EV adoption could increase the electricity demand, necessitating grid upgrades to keep up.

In addition, utilities would face the challenge of supporting and integrating the extra EV loads into the grid. Utilities can incentivize charging EVs during the off-peak period TOU (discussed above) by sending price signals to consumers. This would reduce the stress on the grid and the cost to the consumer. EVs, using emerging vehicle-to-grid (V2G) technologies and other vehicle-grid integration (VGI) approaches, have the potential to be used as DERs to support the grid during peak loads.

There is also a challenge in providing EV benefits in communities with historically lower incomes. Placement of EV chargers in multifamily housing, libraries, and other community areas, and encouragement of electric fleets, can help. However, the anemic secondary market for EVs and the high cost for new EVs still leave the technology beyond the grasp of many low-income Marylanders. Also, a legitimate debate exists whether state support for EVs and charging infrastructure primarily subsidizes the higher-income communities that disproportionately purchase EVs. Equity issues in addressing the continuing need to decarbonize the transportation sector remains an important discussion.

CONCLUSION AND ACTION ITEMS

MAY 2022

DEVELOPED BY
Maryland Energy Administration

Conclusion and Action Items

Maryland continues to move forward in transitioning to a cleaner economy, and the state fully intends to maintain and accelerate this progress. Based on where the state is in its transition and the current operating environment, this section presents a series of recommendations to continue the state's momentum toward sustainably achieving its long-term goals. All recommendations are geared toward providing a smoother energy transition while doing so at the lowest cost and in the most equitable way. These are achievable goals that can be accomplished in the next five years.

Short-term Action Items (one to three years)

1. Support Actions at the PSC for Distribution System Planning
2. Proactive Grid Planning for DERs (Locational Value Study)
3. Mitigate DER System Barriers
4. Encouraging DER Systems as Economic Drivers
5. Strategically Expand Natural Gas Infrastructure
6. Continue Engagement with FERC and PJM
7. Determine Carbon Pricing Impacts
8. Encourage Further Adoption of CHP in Key Sectors
9. Determine Modifications to the EmPOWER Program to Manage the Current and Future Unamortized Balance Including the Use of Performance Incentive Mechanisms
10. Adopt Robust Appliance Energy and Water Efficiency Standards
11. Support the Clean and Renewable Energy Standard (CARES) Legislation
12. Expand Available Offshore Lease Areas
13. Determine Appropriate Approaches of Alternative Fuel Taxation
14. Evaluate the State's Clean Energy Workforce for Growth, Equity, Quality
15. Update the Emergency Fuel Plan
16. Elevate the State's Focus on Energy Security
17. Evaluate How Energy Equity Can Be Further Incorporated into SEIF-funded Energy Programs

Medium-term Action Items (two to five years)

18. Encourage Modifications to Solar Policies and Incentives to Focus on Relieving Energy Burden and Increasing Access to Clean Energy
19. Explore Solar Panel Recycling Best Practices
20. Prepare for Offshore Wind Grid Integration and Storage Management
21. Determine the Potential for a Regional OREC Market
22. Modify Existing Incentives for Residential Energy Storage
23. Assess Potential In-state Deployment of Small Modular Reactors
24. Encourage the Development of Renewable Natural Gas
25. Establish State Fleet Clean Fuel Policy

26. Explore Alternative Fuel Vehicle Access to Tunnels
27. Consider Possible Adjustments to the RGGI Auction Proceeds Formula
28. Revise the Energy Assurance Plan
29. Introduce Natural Gas Efficiency Goal in EmPOWER
30. Adoption of Building Codes and Training
31. Assess State-wide Energy Burden
32. Develop the Offshore Wind Supply Chain in Maryland in Concert With Regional Partners
33. Develop the State's Regulatory Framework for Carbon Capture and Sequestration

Short-term Action Items

Action Item 1: Support Actions at the PSC for Distribution System Planning
MEA and the PSC participated in a two-year program on distribution system planning as part of a National Association of Regulatory Utility Commissioners -NASEO Task Force funded by the DOE. This Task Force worked with a wide range of stakeholders to determine the best approach to distribution system planning, especially to accommodate the growth of DERs.

Pushing for distribution system enhancements through improved communication of stakeholders and strategic deployment of customer-sited technology will be critical to future grid adaptability. Bolstering resilience to both customers and the electricity grid will require that utilities carefully consider and advise on proper siting for solar PV, wind turbines, and large-scale energy storage systems on the distribution grid. Doing so will ensure that constrained portions of the grid are sufficiently bolstered against outage events and that the DERs are geographically located to operate at maximum efficiency. These efforts also maximize ratepayer value, and MEA will continue to support these efforts.

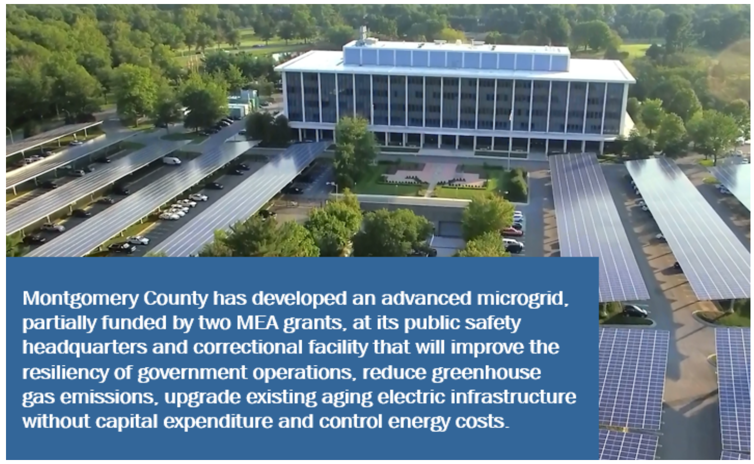
Next Steps
The PSC has convened a more transparent distribution planning process within a PC44 workgroup.[190] If this course of action is taken, the state could support, inform and participate in this process to better understand the process and potentially influence the placement of DERs.

Action Item 2: Proactive Grid Planning for DERs (Locational Value Study)
It would be beneficial for the state to perform a locational value study of the distribution grid to understand the most advantageous locations for generation assets and DERs to provide the most benefit to the grid.

DER site selection depends on many factors, including zoning, permitting, profitability, structural issues on buildings, wetlands avoidance, and many others. However, these are all social and economic factors and do not necessarily correlate to the technical and engineering need for energy injection at a specific point in the grid. Unfortunately, no maps or guides show

[190] See PSC Order No. 89865, Order Initiating Distribution System Planning Work Group (June 23, 2021).

where DERs, like solar energy, could be placed to benefit the grid by providing increased resilience or grid reliability, either under current conditions or the projected power needs of the next 10-20 years. Such maps or studies would help encourage the development of projects in these areas. A detailed study would require the support and participation of the electric distribution utilities and the local planning agencies. This study's output would also be affected by a decision or criteria for adding energy storage on the same circuit or potentially even co-located with a generating system. Such a study, conducted every 10 years or so, would allow developers, cities, counties, and the state to work together to optimally site distributed solar systems, as well as other DERs. Once desired energy injection points are identified, then developers can confidently use siting tools, such as SmartDG+ (a state-sponsored website[191] that provides geographic information system (GIS) maps to help find favorable locations for electrical generation systems) and utility restricted circuit maps to properly size and locate the exact site of a desired DER system.


Montgomery County has developed an advanced microgrid, partially funded by two MEA grants, at its public safety headquarters and correctional facility that will improve the resiliency of government operations, reduce greenhouse gas emissions, upgrade existing aging electric infrastructure without capital expenditure and control energy costs.

Next Steps

Pursue a study of the locational value of DERs to determine beneficial and strategic placement on the Maryland grid in tandem with the utilities and the PC44 Distribution Planning workgroup.

Action Item 3: Mitigate DER System Barriers

Current state laws and regulations prohibit distribution infrastructure not owned by public utilities and electric cooperatives from crossing property lines and aggregating meters and other issues that inhibit effective multi-customer/property DER implementation. This prohibition significantly limits the number of Maryland residents, businesses, and other organizations that can benefit from offsite clean, affordable, and resilient energy provided by large-scale DER systems such as community microgrids. The prohibition limits offtaker facilities to those on the property where the system is installed unless an entity is eligible to participate in virtual net metering such as community solar, which typically does not exceed campus scales. Identifying viable solutions for addressing DER issues where multiple facilities benefit, often crossing property lines and right-of-ways, and the role of utilities is essential to realizing the broader benefits of DERs such as enhanced demand flexibility and the ability to defer costly grid replacements and repairs. Addressing these issues has the potential to benefit ratepayers,

[191] dnr.maryland.gov/pprp/Pages/smartdg.aspx Accessed on March 12, 2021.

commercial enterprises, critical infrastructure, and utilities. The state should engage with utilities, electric cooperatives, and community, emergency managers stakeholders to surmount this barrier, increase the accessibility of large-scale DERs, and fully understand the following items:

a. DER system ownership options and tariff models (e.g., microgrid tariffs and standby charges that reflect actual utility costs of maintaining supplemental service) that deliver the greatest benefits to the community, minimize ratepayer impact, and support overall utility reliability;[192]
b. The costs and benefits of statutory and regulatory modifications required to allow DER system distribution infrastructure to cross property lines or public rights-of-way to ratepayers and to the communities which would benefit from these types of large-scale DER systems; and
c. Appropriate modifications to statutes and regulations which must be made to facilitate beneficial access to large-scale DER systems that bolster community resilience and enhance grid flexibility and resilience.

The state should complete a thorough review to understand better how to permit the installation of large-scale DER systems in ways that will minimize ratepayer costs and maximize the benefits they provide to the communities for which they are designed and to work in synergy with the electricity grid.

Next Steps
The state could conduct outreach to determine barriers to the further adoption of large-scale DER systems. A Request for Information (RFI) can be issued to raise awareness and draw in additional companies. Additional stakeholder outreach can be accomplished through agency contacts. Once this is complete, the next steps can be formulated.

Action Item 4: Encouraging DER Systems as Economic Drivers
Facilitating further adoption of DER systems by Maryland residents, businesses, and other organizations requires that the energy and cost-saving benefits provided are communicated in ways that resonate with the daily needs and operations of the beneficiary of each DER system. Presenting annual kilowatt-hour reductions and their associated cost savings without linking these to operational and quality of life improvements will not deliver the value proposition of DER investment to the individuals responsible for implementing projects. DER marketing strategies by state and local entities should focus on presenting DER systems as tools for achieving these improvements.

Next Steps

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[192] MEA is carefully monitoring the current microgrid tariff and incentive fund being developed in California. microgridknowledge.com/california-approves-microgrid-tariffs/

The state, in cooperation with other stakeholders, could continue and intensify awareness and education of these benefits and facilitate the accessibility of information related to the potential cost savings for businesses and residences by adopting DER systems. Furthermore, additional focus can be placed on resiliency for continuity of operations and for cost savings.

Action Item 5: Strategically Expand Natural Gas Infrastructure
Maryland should expand natural gas distribution service to parts of the state where it can be placed to replace other, higher-emitting and higher cost fuel sources, thereby reducing GHG emissions or costs to areas of the state with economic challenges or vulnerabilities. This approach furthers the interests of environmental and social justice, helping to reduce energy burden through decreasing costs and improving air quality for economically disadvantaged Marylanders.

As is currently underway with a project in Somerset County in the Eastern Shore, such expansion and fuel switching reduce GHG emissions at the source by converting power sources from heating oil and other higher-emitting technologies, and eliminate the mobile point emissions from diesel trucks that deliver physical commodities. Since the fuels or systems targeted for switching in the existing project are some of the dirtiest available, the expansion of natural gas in these scenarios brings immediate cuts to GHG emissions, furthering advancements toward state goals as outlined in the GGRA. While the opportunities to switch from higher-emitting sources are decreasing in-state, opportunities still exist for emissions reductions and will still provide cost-related benefits to residents.

Natural gas service is typically more affordable and reliable than other sources, and the expansion of energy-transportation infrastructure is especially important for economically challenged communities. The state's longer-term goal should be to encourage the conversion of the natural gas infrastructure network to accommodate more certified gas, biogas, and other renewable natural gases, and potentially hydrogen. This was discussed earlier in the natural gas section, and the state needs to explore conversion pathways that maintain the infrastructure while reorienting it to a low carbon network.

Next Steps
The state partners with gas utilities to initiate a study to better understand plausible conversion pathways for decarbonized natural gas infrastructure, in particular RNG or hydrogen. This will include the business and energy infrastructure required and the status of the technologies that could be used for such conversions.

Action Item 6: Continue Engagement with FERC and PJM
Maryland has been active whenever possible on federal matters, particularly at FERC. The PSC and OPC are regularly engaged with PJM and FERC. However, over the past couple of years, FERC-related actions have been viewed by states to have negatively impacted the sovereign

ability of the states to determine their own resource mix, and infringed too far into the rights of states;[193] which, in Maryland, has brought in the further engagement of MEA.

Three issues, the 2019 MOPR ruling, FERC's docket on net energy metering, and the carbon pricing technical conference, are all areas where multiple state agencies (typically the PSC, OPC, and MEA) have monitored or directly intervened.

State agencies have defended Maryland's rights to exert authority over its power mix; fought against a potential ruling to treat NEM as a wholesale transaction under FERC jurisdiction, potentially blunting the state's solar policy effectiveness. They have also engaged in the carbon pricing conference to better position the state for any changes resulting from PJM or FERC decisions. These agencies continue to intervene wherever necessary to safeguard state interests and continue to participate in the current discussions surrounding the capacity market and transmission expansion, among others.

Next Steps
Monitor, file, and safeguard state autonomy and interests in these regional fora and stakeholder processes. Primarily, work to ensure capacity market issues are resolved to the state's satisfaction.

Action Item 7: Determine Carbon Pricing Impacts
Adopting an appropriate carbon pricing approach could be vital in achieving the state's energy and climate goals. The state must understand the implications of any state-determined, regional, or national carbon pricing policy. The effects of several carbon pricing schemes in Europe and programs being considered by the federal government are good places to watch that process.

It is critical to understand the costs and benefits of carbon pricing on Maryland ratepayers, and how the state can invest resources from a carbon tax towards social programs and services and potentially other programs to reduce carbon emissions further. Addressing the regressive impacts of a carbon tax will be especially important given compounding costs from other policies that ultimately assess costs to Maryland's residents.

Next Steps
Initiate a study to determine the economic impacts and carbon emission reduction potential of varying levels of carbon pricing applications, including different price levels.

Action Item 8: Encourage Further Adoption of CHP in Key Sectors
CHP technology has been available for over a century, but it has not been widely deployed until the past decade when many different industries began focusing more on reducing energy consumption, improving sustainability, and increasing energy resilience in response to a higher

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[193] Cornell Law School, Legal Information Institute, 16 U.S. Code CHAPTER 12—FEDERAL REGULATION AND DEVELOPMENT OF POWER, law.cornell.edu/uscode/text/16/chapter-12.

number and increased severity of negative impacts to utility infrastructure (e.g., hurricanes, severe storms, cyberattacks, aging infrastructure, and rapidly-increasing energy demand as more sectors digitize and electrify). With this newfound demand has come increased versatility in CHP system types, sizes, and applications to meet the unique needs of each energy-intensive industry that can benefit from its deployment.

Maryland's economy comprises many industry types, almost all of which can benefit from the integration of CHP systems where they are strategically and economically viable. The state should continue and accelerate its efforts to deploy CHP systems where they will reduce energy costs, bolster critical infrastructure, businesses, and other organizations against the impacts of power outages, reduce energy demand and consumption, and improve sustainability through decreased GHG emissions. This section presents the key industries of focus now and in the near future.

Critical Infrastructure

Continuous access to reliable electricity and thermal energy is vital for the critical infrastructure and services that serve the state. Healthcare facilities cannot experience a loss of power or heat energy at any point in time; such an outcome would immediately threaten the life and safety of hospital patients, staff, visitors, and the communities which these entities serve. Wastewater treatment facilities are crucial for the provision of potable water to vast swaths of populations, and their inability to operate as the result of a power outage would cause widespread disruption and immediate threat to public health and safety, as well as human and animal life. CHP systems can benefit these entities and are already doing so across Maryland.

Combined Heat and Power (CHP) systems maximize energy efficiency and reduce waste heat; recycling the heat. CHP improves energy resiliency, reduce greenhouse gas emissions and lessens demand on the grid. Some CHP systems can offer islanding capability, enabling the business to operate independent of the grid in the event of sever weather emergencies

Healthcare facilities are already required by federal law to have backup emergency generation onsite, but it typically comes in the form of diesel generators that have limited fuel supplies. Grid outage durations are difficult to predict, and a finite fuel supply runs the risk of depleting before grid services can be restored. CHP systems with the ability to either quickly restart or continue the provision of power seamlessly after the loss of power provide electricity and thermal energy to critical facility loads virtually indefinitely as long as the fuel supply (typically utility-supplied natural gas) remains available. Many hospitals across the state have installed these systems for that very reason - examples include the Baltimore Washington Medical Center in Glen Burnie; Peninsula Regional Medical Center in Salisbury; Doctors Community Hospital in Goddard; and Union Hospital in Elkton. Implementing CHP in these facilities does not require the removal of the emergency backup diesel generation either. These generators are still statutorily required, and they can be configured with CHP systems to add another level of backup if the CHP systems fail.

Wastewater treatment plants require continuous access to electricity to power pumps and filtration equipment, as well as thermal energy required for heat-intensive parts of the treatment and sterilization process. The inability of a wastewater treatment plant to operate for an indefinite period would mean a catastrophic outcome for the communities and facilities. Potable water is essential for a functional society, and just a few hours without access is enough to cause substantial harm. This is another opportunity for CHP implementation; it can provide the electricity needed to run essential loads such as the pumps, filtration and sterilization systems, and emergency lighting. Additionally, the thermal energy can be used to offset the amount of traditional boiler-fired heating needed, thereby reducing GHG emissions and costs in both normal and grid outage situations. This approach to system support using thermal energy is applied at the Washington Suburban Sanitary Commission, which is implementing a CHP system at its Piscataway Water Resource Recovery Facility in Accokeek.

Agriculture

In recent years, agricultural businesses have sought CHP technologies to improve operational efficiencies, reduce costs, and safeguard crops against failures. Maryland is at a latitude within a temperate climate zone, and thus temperatures and precipitation amounts fluctuate widely throughout the year. Crops require relatively stable temperatures and irrigation to thrive and maximize their yield, and the ideal conditions for doing so outside of a controlled environment are only available during a relatively short time frame: the spring and summer months. As consumer demand for produce is present year-round, agricultural producers rely on controlled environments to sustain optimal growing conditions by growing crops in greenhouses throughout the year. Maintaining these conditions within greenhouses requires a substantial amount of electricity and thermal energy, and CHP technologies can meet these intense energy demands sustainably and at a low cost by virtue of their design and operation. CHP offers many advantages, including the affordable electricity and thermal energy they supply, the versatility of fuel with which they can operate, the technologies with which they can be paired, and potentially the ability to capture and utilize CO_2 produced. A number of farm and greenhouse operations are in various stages of development and installation of energy capital improvement projects, which include CHP technologies for these reasons. Further encouragement of this approach should be prioritized by the state, local jurisdictions, and utilities incentive programs.

Relying on grid-purchased electricity and traditional thermal energy production systems is incredibly costly to greenhouse operations, and the loss of power from grid failure can mean hundreds of thousands of dollars of ruined crops. Not only is this potential failure financially detrimental to the greenhouse industry, but it also risks causing substantial disruptions to local and regional food supply chains. Implementing CHP technologies at these facilities provides them with the electrical and thermal energy needed to operate at significantly lower prices, and it safeguards them from crop failures when grid electricity is unavailable.

Additionally, while low in volume, the CO_2 produced by the operation of CHP systems can be captured and used to enhance the quality of crops produced in greenhouses. This unique application virtually eliminates the release of CO_2 to the environment and turns it into a value-added input for industry operations. By encouraging this type of CHP solution, Maryland could attract more greenhouse operations to locate within the state. This type of value-added operation would bring much-needed economic investment to areas such as western Maryland and the Eastern Shore, and it would increase the abundance of locally sourced food supply.

Advanced Manufacturing

Maryland manufactures products for a diverse set of industries, and the manufacturing processes are highly energy-intensive in terms of electricity and thermal energy. Some of the most intense of these processes are utilized by the biopharmaceutical and chemical products industries. Power disruptions to these entities become extremely expensive in a very short amount of time, and can cause substantial and prolonged disruptions to product supply chains. Such disruptions have both public safety and economic implications: shortages of essential products and the scarcity created by that scenario will drive prices to unaffordable levels.

CHP can also mitigate these effects; power and heat can be provided to continue manufacturing throughout an outage and keep supply chains moving. Several manufacturers in Maryland have sought CHP for these reasons. For example, Becton Dickinson & Company, at the time of this publication, is implementing a CHP system at its Cockeysville production plant, which produces medical products. W.R. Grace and Company, a chemical manufacturer based in Baltimore, installed a CHP system that provides thermal energy as part of its production processes.

CHP systems installed by manufacturers can also dramatically reduce operating expenditures by providing much lower-cost and more efficient energy. W.R. Grace and Company, for example, has realized about $1.2 million in annual operating savings as a result of installing its CHP system. The state should continue the adoption of CHP technologies in this industry to keep operating costs low and reliability high.

Multifamily Housing

CHP technologies have recently been pursued by the multifamily housing industry in Maryland, thanks to the prevalence of small-scale, packaged CHP units. Often referred to as “micro-CHP,” these systems are small in size and pre-assembled in “packaged” or “containerized” configurations that make installation simple and low-cost. While the energy demand of a multifamily housing complex with centralized utilities distributed amongst the occupants is much lower than that of the aforementioned industries, electric and heating demand is consistent enough that a properly-sized CHP system can bolster energy resilience, reduce energy cost, and enhance efficiency and sustainability of the complex. Occupants can benefit from more reliable electricity, HVAC, and hot water; and the energy savings from configuring CHP in this way can allow the complex to invest in other upgrades or be passed through to the occupants.

CHP systems installed in multifamily housing are especially beneficial for LMI households, as occupants typically have a disproportionately high energy burden. Housing complexes that have central utility plants can install CHP systems that dramatically reduce energy expenditures, which can be passed through to the occupants, reducing energy burden, and improving socioeconomic equity. This approach is already being undertaken by the Bauer Park Apartment complex in Rockville, which is an LMI multifamily housing community owned and operated by the Housing Opportunities Commission of Montgomery County. The project is overhauling its central utility plant, which includes the implementation of a CHP system to enhance power reliability and reduce the cost of rent for its tenants experiencing disproportionately higher vulnerabilities and energy burdens.

The state should continue encouraging the adoption of packaged CHP systems in the multifamily sector, particularly those complexes which primarily serve LMI and other populations experiencing vulnerabilities. Reducing energy burden improves socioeconomic equity and quality of life. CHP technology can help achieve this while also enhancing sustainability.

Next Steps

Pursue marketing and outreach, with existing CHP programs, such as those at MEA, to solicit interest in these various market sectors to pursue these options for electricity and thermal energy management. Explore partnership opportunities jointly with industry advocacy organizations such as the Department of Commerce, MARBIDCO and the Regional Manufacturing Institute (RMI), as well as MDEM for critical infrastructure, to expand grant opportunities. Engage with local governments and housing authorities to strategically market CHP to complexes, which can benefit from resiliency, replacement of inefficient space heating systems that do not leverage CHP, and reduced operating cost pressure that will help maintain competitiveness and low pass through costs to tenants.

Action Item 9: Determine Modifications to the EmPOWER Program to Manage the Current and Future Unamortized Balance Including the Use of Performance Incentive Mechanisms

The cost recovery mechanism in EmPOWER Maryland has undergone minor substantive changes since its implementation. The amortization schedule has escalated costs in recent years—inclusive of the accrued interest—and is now over $820 million. MEA analyzed two mechanisms in 2020, but did not recommend implementing them.[194] The analysis was built on the current structure of the EmPOWER program with the addition of a performance mechanism that sought to reduce costs to ratepayers by incentivizing efficiency in spending and beginning

[194] Maryland Energy Administration, Prepared by Oculus CAS, LLC., EmPOWER Program Cost Analysis, psc.state.md.us/search-results/?q=9648&x.x=17&x.y=19&search=all&search=case.

the process toward aligning program costs and revenue collected annually. The effect of aligning program costs and revenues collected is a reduction of interest paid overtime. The report determined that the state could reduce the unamortized balance over 10 years. Once eliminated, the EmPOWER Program costs would be expensed on an annual basis, and any program costs that are not recovered in the program year would be recovered in the surcharge through the true-up process. The estimated savings over the 10 years would be over $150 million. As we contemplate the future of energy efficiency in the state beyond 2023, performance incentives are one avenue by which cost reduction may be sought.

Aside from using performance incentive mechanisms, more broadly, any energy efficiency and conservation plans should address the uncollected program costs from the EmPOWER Maryland Program. The state should consider less costly alternatives to funding the coordinated energy policy efforts to reduce the cost to ratepayers and implement mechanisms to determine costs and benefits reliably.

Some options listed in the Oculus report to address uncollected program costs are:

> Status Quo: This option avoids dramatic changes to Ratepayer Surcharges that lead to rate spikes and delivers the lowest average Ratepayer Impact over the 10-year period. However, the Unamortized Balance remains high and is an ongoing burden for Ratepayers. Additionally, the 10-year stream of Utility Revenue is well above the other options.
>
> Option 1: This option repays 100% of the Unamortized Balance. The Ratepayer Impact is moderated by a more than 50% cut in the Utility Rate of Return, but the average monthly impact over the 10-year period remains higher than the Status Quo.
>
> Option 2: This option also repays 100% of the Unamortized Balance. The Ratepayer Impact is the most pronounced, with a significant spike and the highest average of the 10-year period.

These ideas should be sufficient to start a broader conversation on managing these costs.

Next Steps

1) Further explore and support performance incentive mechanisms that would mitigate or eliminate the uncollected program costs in the future. This effort can be done through existing avenues at the PSC with involvement by MEA.

2) While deciding the best strategic approach the state would like to take to address the large and growing unamortized balance, determining programmatic changes will be essential. The state should seek out new cost-effective measures for increasing energy efficiency in Maryland. These measures must be Maryland-specific and able to meet

existing goals. The findings and support from such a project would then be used to inform discussions currently underway.

Action Item 10: Adopt Robust Appliance Standards

Inefficient appliances saddle consumers with excessive energy costs for the life of the products and are unnecessary in many cases where efficient comparably-priced products exist. Appliance efficiency standards set the baseline for the efficiency of these appliances and other products. These standards save energy by directing consumers to more efficient appliance models, reducing energy waste while also reducing pollutants, and many efficient appliances incorporate smart features to reduce consumption at certain times, reducing load and improving electric system reliability.

A typical household saves hundreds of dollars per year on utility bills simply by buying household appliances, and heating, cooling, and lighting products that comply with minimum standards.[195] A 2017 study by ASAP and ACEEE estimated that average household savings by state ranged from 11% to 27% of total consumer utility bills, with a national average of 16%.[196]

In 2004 the Energy Efficiency Standards Act (EESA of 2004) became law in Maryland. The General Assembly passed the EESA to establish minimum energy efficiency standards on nine separate products. In 2007, the EESA was amended to establish standards for seven additional types of appliances. MEA officially adopted regulations implementing the standards under the EESA. MEA was directed to consider and propose standards to the General Assembly for products not already subject to efficiency standards and revised, more stringent amendments to existing standards.[197] Of the products for which Maryland has previously introduced standards (EESA 2004, 2007), only two have not yet been preempted by federal standards: bottle-type water dispensers and commercial hot-food holding cabinets.

However, there are many appliances for which effective standards have been developed and verified by credible third parties such as the federal ENERGY STAR program. This includes commercial dishwashers, commercial steam cookers, EV charging equipment, water coolers, portable electric spas along with showerheads, toilets, faucets, and urinals. Collectively, these measures can save energy either by the commercial or residential end-user or in other areas of the economy such as potable water and wastewater treatment. Water savings provide additional and significant cost savings potential to the consumer for many of these appliances.

Adopting these standards helps to eliminate products with higher day-to-day operating costs while driving a market that will support the growth of energy efficiency improvements and innovations. In recognition of these benefits, this bill will establish minimum efficiency

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[195] appliance-standards.org/sites/default/files/Fact%20Sheet_Why%20National%20Appliance%20Standards%20Mar%202017.pdf

[196] aceee.org/sites/default/files/energy-saving-states-america.pdf

[197] programs.dsireusa.org/system/program/detail/1564

standards for selected residential and commercial products sold or installed in Maryland. Aligning appliance standards with neighboring jurisdictions will help streamline the market for retailers and simplify consumer education making the offering and purchase of efficient equipment automatic for retailers and customers.

Next Steps:
Continue to collaborate with ASAP, industry stakeholders and others to evaluate which appliances can be adopted that generate significant savings with little or no lifecycle cost to consumers. Maryland could adopt standards for appliances without an existing federal standard and backstop with federal standards if needed.

Action Item 11: Support the Clean and Renewable Energy Standard (CARES) Legislation

The CARES legislation, proposed by Governor Larry Hogan, offered a path to 100% clean electricity by 2040. The 2020 bill would have added "Clean Energy" to the RPS, creating a Clean and Renewable Energy Standard. The legislation also removed dirtier technologies currently eligible under the RPS and expanded eligibility for other resources, including emerging technologies. Clean Energy includes technologies such as natural gas paired with a carbon capture system, new nuclear generation assets, including small modular reactors, combined heat and power systems. CARES also would extend the eligibility of hydroelectric power permanently. CARES is intentionally technology-agnostic/neutral and would accept additional net-zero carbon technologies as they become available at scale. Had it been enacted by the General Assembly, the bill would have been a great leap forward in attaining the state's clean energy and climate change objectives.

Though the General Assembly never did vote on the Governor's CARES initiative, nor the 2021 version of the bill put forth as a departmental bill by MEA, the General Assembly has adopted several of the objectives of the original legislation piecemeal. Aggregately, changes to the RPS that were proposed in CARES, such as extending eligibility of hydroelectric generation, removal of "black liquor" from eligibility, reducing the burdens placed upon Maryland's municipal utilities, and taking steps to reduce the meaningful financial impact borne by ratepayers, have all been enacted by the legislature in some form or another.

Next Steps
MEA and MDE, the lead agencies that developed CARES, should continue to work toward potentially reintroducing modified legislation in the next legislative session to institute provisions of CARES that have yet to be adopted/debated, including inclusion of new carbon-free nuclear generation, further reducing ratepayer impact, promotion of carbon capture, and creating a more technology neutral approach to incentivising clean energy and specifically for DERs.

Action Item 12: Evaluate Opportunities to Expand Offshore Lease Areas
Maryland will require additional offshore wind energy lease areas in addition to the existing lease areas to have sufficient space for needed capacity to meet current and future clean energy goals. This effort will need to be facilitated through the BOEM Intergovernmental Renewable Energy Task Force siting process. Additional lease areas could encourage new offshore wind developers to enter the mid-Atlantic market, stimulating competition among developers participating in Maryland's OREC Program and opening up opportunities for new community sustaining jobs such as advanced manufacturing. Adding lease areas further from shore would also address some of the concerns held by coastal communities regarding offshore wind project siting and potential impacts to other maritime industries, wildlife, habitat, and ecosystems.

To move forward with a request for additional lease areas, Maryland would make a formal request to BOEM for additional lease areas off the coast. The request would be made to emphasize stakeholder interest in the Eastern Shore by requesting lease areas a minimum distance from the shore to not impact local visibility or tourism.

Next Steps:
MEA and other stakeholders are evaluating the opportunity for additional lease areas and working with BOEM to understand the process. The state should continue to review opportunities and work with stakeholders to determine when and if a request for new lease areas is appropriate.

Action Item 13: Determine Appropriate Approaches for EV Drivers to Fairly Contribute to Transportation Infrastructure
Further study needs to be conducted to identify possible ways to have EV drivers fairly contribute to maintaining transportation infrastructure without negatively impacting the adoption of EVs. Currently, Maryland's Transportation Trust Fund is financed by a motor fuel tax;[198] however, EVs do not pay a motor fuel tax. It is critical to understand the full range of possible fuel taxation and fee options in light of the state's ZEV goals balanced with the need to maintain road infrastructure.

Pilot programs and planning activities are already under consideration in other states in preparation for EV-filled roads to ensure a seamless transition from gasoline and diesel-powered vehicles to EVs. Some approaches would include using gasoline gallon equivalent and diesel gallon equivalent units for assessing contributions. This method would help ensure that rates charged for these fuels do not exceed rates imposed on gasoline and diesel fuel, but it would still need to be determined if this approach is best for Maryland.

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[198] Motor Fuel Tax Rates, marylandtaxes.gov/forms/compliance_forms/MFT_RatesPerGallon_06012020.pdf, accessed May 6, 2021.

Next Steps
Building on an MEA policy paper to a Joint Chairman's Request (JCR) request on this topic, MEA can work with MDOT and ZEEVIC to further study the most appropriate Maryland-specific approaches to this issue. More directly, a study to understand the impacts of a shift to alternative fuels on revenues to the Transportation Trust Fund would assist decision-making going forward.

Action Item 14: Evaluate the State's Clean Energy Workforce for Growth, Equity, Quality
MEA awarded NASEO an Energy and Employment Data Grant to create a series of reports on the status of Maryland's energy sector employment, providing insight on the economic effects of the state's policies and identifying specific opportunities for continued energy sector employment growth. The grant funds allow NASEO to conduct a deep-dive analysis into Maryland jobs data related to energy and oversee the completion of Maryland statewide data collection and analysis of COVID-19, and employment in sectors relevant to energy (e.g., fuels, electric power generation, transmission/distribution/storage, energy efficiency, and motor vehicles). The findings will be essential to aligning MEA, partner agencies, and other organizations' efforts to recover from the COVID-19 pandemic.

A research team of experienced methodologists committed to developing and implementing the most effective research plan based on the state's objectives will create the reports. The data collection and analysis will result in highly reliable and credible information to assist Maryland's energy policymakers, local governments, economic development authorities, universities, private companies, and others make informed decisions. The analysis and reports will develop consistent and comparable statistics relative to other states.

Expanding the amount of information available related to the nature, scale, quality, and trajectory of Maryland's clean energy jobs before, during, and after the COVID-19 pandemic will benefit Maryland and the region. The findings and Maryland-specific reports produced by NASEO will be made broadly available to inform key stakeholders and the general public.

Next Steps
As a baseline assessment of the state's clean energy workforce, wage quality, and workforce opportunities, this project has made rapid progress. The resulting study will need to be properly disseminated to the public and relevant stakeholders for maximum impact. MEA will coordinate with Commerce, Labor, Governor's Office of Small, Minority, and Women Business Affairs, federal agencies, and other stakeholders to identify data gaps, emphasizing leveraging cleantech investment to improve wage quality and address equity gaps.

Action Item 15: Update the Emergency Fuel Plan
The emergency fuel plan is a document the state can utilize to respond to emergency fuel supply situations appropriately. This is especially important for natural disasters and other supply interruptions such as the Colonial Pipeline event in May 2021.

On May 7, 2021, the Colonial Pipeline Company learned it was the victim of a cybersecurity attack that involved ransomware. The pipeline, which runs from the Gulf Coast to New Jersey, is the largest conduit for gasoline in the country, transporting nearly half of the gasoline used on the East Coast. In response, Colonial proactively took certain systems offline to contain the threat, which temporarily halted all pipeline operations and affected some of their IT systems. As a result of the pipeline shut down, panic buying of gasoline was prevalent, leading to gas shortages reported through state reporting, DOE, and GasBuddy throughout the East Coast. On May 12, Colonial Pipeline initiated the restart of pipeline operations; following this restart, it took several days for the product delivery supply chain to return to normal. MEA shares the State Coordinating Function-12 (Utility and Fuels) lead with the PSC, but is the lead agency regarding transportation fuels.[199] As a result of the Colonial Pipeline shutdown, MEA took a lead role, working with federal and state agencies to monitor and report pertinent information throughout the event.

In light of recent emergency pipeline events and responsiveness to statutory duties, MEA is updating the Maryland Fuel Contingency Plan. This plan is the procedural document that stems from an EAP, and is utilized by the SCF-12 to support and coordinate the state-level restoration of commodity fuels in affected areas during times of an emergency.

Next Steps

MEA has initiated the process to test and finalize a fuel plan that meets the needs of the state in a fuel emergency. MEA has launched the effort to update the plan, update key templates, coordinate with local governments and other stakeholders, leveraging lessons learned, and the knowledge of state and federal partners. This plan will focus on information sharing and communication between all relevant parties and ensure all statutory responsibilities are covered.

Action Item 16: Elevate the State's Focus on Energy Security

Energy infrastructure, a critical backbone of the U.S. economy, includes the electricity transmission and distribution grid, generation assets, and transmission pipelines. Some aspects of the energy sector are regulated federally, while others are regulated at the state level. While diverse and varying in type and oversight, these energy assets must be kept both physically and cyber secure.

Energy infrastructure faces increasing cybersecurity threats. The potential risks to energy infrastructure were most recently exemplified by the multi-day interruption of the Colonial Pipeline caused by a ransomware attack.

The state has already recognized the importance of cybersecurity, and a Maryland Cybersecurity Council was formed in 2015.[200] While the scope of the council already encompasses certain

[199] law.justia.com/codes/maryland/2015/article-gsg/title-9/subtitle-20/section-9-2005/
[200] umgc.edu/administration/leadership-and-governance/boards-and-committees/maryland-cybersecurity-council/index.cfm

critical infrastructure, there are no representatives from the energy industry on the council. In addition, while MEA and the PSC participate in energy emergency planning activities, no one from MEA or the PSC is listed as a member of the council.

Next Steps

The membership of the Maryland Cybersecurity Council should be reviewed for possible expansion to representatives of the energy industry, as well as MEA and the PSC.

Action Item 17: Evaluate How Energy Equity Can Be Further Incorporated into SEIF-funded Energy Programs

A core component of providing Marylanders with clean, reliable, and affordable energy is recognizing that our State's energy landscape and services are only as effective and equitable as they are so experienced by all Marylanders, more specifically those facing disproportionate socioeconomic and environmental vulnerabilities, challenges, and burdens. Maryland has made some key policy decisions and provided resources and incentives within the past twenty years that have helped to accelerate the adoption of clean, efficient energy technologies and lower energy burden. These include substantial legislative actions such as the Renewable Portfolio Standard (RPS) and EmPOWER Maryland Act, which respectively set Maryland on a path to clean energy and reduced energy consumption through more efficient technology options and energy management strategies. Incentives offered through the Maryland Energy Administration (MEA), Department of Housing and Community Development (DHCD), Maryland Department of the Environment (MDE), Maryland Department of Agriculture (MDA), EmPOWER Maryland utilities, and others have helped reduce the up-front costs associated with these technologies which have made them more widely accessible to the general Maryland population.

The administration of these programs and statutes has also helped to identify energy-related socioeconomic challenges and disequities that have historically and disproportionately affected minority populations and those experiencing low-to-moderate income (LMI), environmental degradation, environmental racism, language isolation, among many others. A number of State incentives and resources have been offered to help mitigate these challenges and promote diversity, enhance equity, and foster inclusion of those communities to reduce their energy burden, improve their access to clean energy sources, enhance the reliability of the energy provided to them, and help mitigate the impacts of climate change and other environmental hazards produced by antiquated energy systems and technologies. Examples include income-based renewable energy, energy efficiency, and weatherization programs offered by MEA and DHCD, appliance rebate programs offered by the EmPOWER Maryland utilities, and an affordable financing program offered by the Maryland Clean Energy Center (MCEC).

These programs have historically been and continue to be very successful and utilized by Marylanders who most need them. However, the abundance of data received from their operation and results as well as more granular demographical, geographical, and environmental information from local, State, federal and other sources has given our State significant opportunity to take these efforts further. Diversity, equity, and inclusion (DEI) have been a priority focus of the energy industry and governmental bodies across the State within recent years, and their importance was galvanized during the hardships faced by Marylanders experiencing these vulnerabilities and challenges during the COVID-19 pandemic. Maryland has committed to growing solutions founded on DEI, and has already begun to execute them.

Recently, MEA created a DEI Committee whose mission is to promote and expand DEI goals and initiatives in its incentive programs, and in its day-to-day operations, which will be core to FY23 program planning and beyond. Some key objectives include the following:

- Continue to implement, grow, and cement DEI practices, ideals, and education in agency operations and administration and lead by example;
- Evaluate the impact of incentives awarded by MEA on communities experiencing socioeconomic and environmental challenges and vulnerabilities;
- Identify programming components that have resulted in relevant desired outcomes and those that have not;
- Ensure programming goals align with prioritizing DEI-focused outcomes and employ the relevant targeted demographics, incentive structures, stakeholder engagement, and marketing/outreach strategies necessary to do so;
- Identify which DEI-focused models hold replicability and scalability potential; and
- Elevate and showcase relevant success stories and incorporate authentic feedback from communities and their leaders that have benefitted from relevant programs.

More information on MEA's DEI-focused programs is provided in the following sections.

Low-to-Moderate Income Energy Efficiency Program: MEA has offered the LMI Energy Efficiency Program (LMI-EE) for more than 12 years, one of MEA's longest standing and most in-demand programs.[201] The program provides energy-efficiency improvements to single-family homes occupied by LMI Marylanders as well as multi-family communities and, in many cases, commercial buildings that support LMI residents. This program differs substantially from traditional weatherization programs as it focuses on developing capacity amongst local governments and community-based organizations to deliver energy efficiency programming and retrofits instead of only implementing retrofits. This formula enables ground-up leadership from communities to address their needs while creating local jobs. During the previous six years alone, the program has provided funds to retrofit nearly 9,700 homes and buildings, investing almost $41 million dollars, saving over $3.4 million per year in energy costs while creating over

[201] The LMI Energy Efficiency program is synonymous with its predecessor program's branding, the LMI Clean Energy Communities Program.

360,000 work hours. The program has saved an estimated 16,301,639 kWh of electricity, 424,542 therms of natural gas while reducing GHG emissions by 11,000 tons per year. In FY22, MEA introduced a supplemental pilot program to offer solar as part of LMI-EE programs. This program intends to develop the capacity of local organizations to assess the feasibility of and incorporate solar into their retrofit offerings creating local jobs and further reducing the energy burden of participating households. It will initially focus on single-family homes; but if successful, MEA hopes to expand the program to provide benefits to a wide array of building types.

Community Solar: Community solar provides an opportunity for individuals and commercial organizations that do not have access to solar on their own roofs due to building type, building condition, location, tree shading, building rental, or where solar is simply cost-prohibitive to access. Community solar is particularly valuable where it can provide an option for LMI residents to access clean energy while reducing utility costs. The PSC is the lead agency for Maryland's seven-year community solar pilot, which provides 583 MW of capacity, with at least 52.5 MW reserved for LMI subscribers (at least 9% of the program total).[202] MEA helps ensure that a significant portion of these projects will be available for LMI customers by providing its Community Solar LMI-PPA Grant Program.[203] This program requires participating developers and subscriber organizations to offer a minimum of 30% of a project's output energy to Maryland LMI subscribers. This grant program allows community solar project developers to implement subscription contracts that meet the needs of the LMI subscriber population, while at the same time providing savings to the LMI subscriber of approximately 25% below the costs of a utility's retail cost of electricity.

Offshore Wind Workforce Development and Capital Expenditure Program: This program collectively provides funds to help develop the Maryland workforce by investing in partner-driven workforce development programs to train workers who can participate in the offshore wind industry or others that require highly skilled workers such as welders. MEA supports program providers in offering fundamental training on both key skills such as welding, fitting, and other trades that apply to the OSW industry and other high-paying fields. In addition, MEA works with key training centers that support accreditation to deliver curriculum under key standards, such as the Global Wind Organization, that promote safety and productivity in the maritime environment. The OSW capital expenditure program fosters capital expenditures for business expansion into the offshore wind supply chain, including facilities and equipment, many of the beneficiaries of which are small and minority business-owned enterprises.

MEA continues to work with partner state agencies to identify the issues, many of which are local, and develop innovative solutions. As policy options are formulated and MEA develops

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[202] Maryland Community Solar Pilot Program psc.state.md.us/electricity/community-solar-pilot-program/

[203] energy.maryland.gov/residential/Pages/CommunitySolarLMI-PPA.aspx

programs for FY23, and beyond, the agency will work with a diverse range of partners and stakeholders to further advance the state's consideration of these essential issues.

Next Steps

Achieving DEI-centric outcomes will require a comprehensive and collaborative approach between a plethora of stakeholders sharing, growing, and dispatching knowledge and resources to devise relevant solutions and strategies. These include but are not limited to:

- State agencies and departments;
- Local governments;
- Federal agencies and departments;
- Nonprofit organizations;
- Utilities;
- Communities;
- Advocacy groups and organizations;
- Academic institutions;
- Cultural and heritage organizations;
- and many others.

DEI principles, practices, and strategies will be key to achieve the goals and objectives identified below. This list is expected to grow and evolve as outcomes from programs, policies, and initiatives manifest:

- Reduce energy burden for Marylanders experiencing LMI through energy efficiency upgrades, weatherization, and improved access to the benefits of clean energy systems;

- Bolster the energy resilience of critical infrastructure and services that our State, especially communities experiencing vulnerabilities, depend upon;

- Improve access to reliable public transportation options through the dispatch of electric and alternative fuel vehicles and fleets;

- Grow employment opportunities in the energy sector to provide jobs for Marylanders in our transition to a clean energy economy;

- Improve the energy resilience and independence of communities through the use of distributed energy resource (DER) systems such as microgrids and resiliency hubs; and

- Curtail greenhouse gas and particulate matter emissions by transitioning off of dirty energy sources so that air quality is improved and the impacts of climate change are mitigated.

Medium-term Action Items

Action Item 18: Encourage Modifications to Solar Policies and Incentives to Focus on Relieving Energy Burden and Increasing Access to Clean Energy
Extending solar PV technology to all Marylanders is vital to achieving the state's clean energy goals. The LMI population faces unique challenges in accessing solar PV technologies and benefitting from incentive programs and policies such as tax credits do not provide an equitable benefit. Many LMI individuals do not own the homes in which they reside. Options to access solar energy exist, such as energy supply contracts from solar PV energy suppliers, but they seldom provide significant reductions in monthly expenses and hence do not significantly reduce the energy burden to LMI households.

Low-income Marylanders who own their residences face high up-front costs if they consider purchasing solar PV systems and may not have sufficient discretionary income to afford them. Financing products are available from many solar PV companies, but LMI customers are unlikely to pursue them to avoid increasing monthly expenses. Three areas need to be addressed: HUD requirements for eligibility, broadening the use of ACP payments, and establishing a central, authoritative website for the community solar program.

Bolster MEA's Successful Low to Moderate Income Energy Efficiency Program to Incorporate Solar and Energy Storage

MEA currently administers the LMI-EE Program, which provides grants to approximately 20 community and local government organizations working at the local level to provide energy efficiency projects on homes and buildings occupied or that benefit LMI Marylanders. This program provides critical, community-based capacity that expands the clean energy workforce while addressing equity gaps in who benefits from energy efficiency investment. MEA launched a pilot program in FY22 that provides supplemental grants to organizations engaged in the LMI-EE Program to allow them to add solar to single-family low-income homes where appropriate, given the home's condition. The program also anticipates making weatherization projects solar-ready to enable easy integration of clean energy later. MEA will also work with stakeholders to identify future options for incorporating storage for communities and residents with a definitive need for highly resilient power.

Allowance for HUD Requirements:
The Clean Energy Jobs Act of 2019 currently defines low income as a household with income less than 175% of the federal poverty level. This 175% of the federal poverty level criteria adjusts based on the size of the household, but does not change based on the cost of housing or the cost of living in the residence area. Many public housing projects use an alternative definition of low income instead of determining residence eligibility based on

the U.S. Department of Housing and Urban Development (HUD) income requirements which tend to be based on area median income levels. As such, a hypothetical project that would qualify as low-income under HUD criteria may be ineligible for assistance under the 175% of federal poverty definition. It is recommended that the definition of low-income be broadened in the SEIF statute to allow the HUD definition of low-income to not unnecessarily restrict low-income solar projects that could benefit from potential future ACP payments.

In 2020, MEA initiated community solar projects that will yield renters a 25% reduction in energy costs for 20 years.

Broaden the Use of ACP Funds:
The Clean Energy Jobs Act of 2019 directs any ACP payments realized under Maryland's RPS into the SEIF for use on projects owned by or directly benefit low-income Maryland residents.[204] To date, ACP funding derived through the RPS has been relatively minimal as sufficient RECs have continued to be available to meet the requirements of the RPS. However, suppose this changes in the future and ACP funds are available. It is recommended that to comply with energy best practices, funds that result from shortfalls in the solar carveout goals established in the RPS should also be utilized to first conduct energy audits and conduct weatherization and energy efficiency upgrades on low-income homes selected to receive solar systems. The first rule of sizing a solar system is to ensure the building has an energy audit conducted and has implemented cost-efficient energy efficiency measures. Similarly, Maryland should refrain from installing solar systems on homes that have not already been weatherized and upgraded with cost-effective energy efficiency measures. Doing so reduces the annual energy usage, and hence reduces the necessary size of the overall solar system and related system costs.

Establish a Central Website for the Community Solar Pilot Program:
A robust community solar program is vital to ensure all Marylanders can access clean energy. An NREL study concluded that about 75% of the United States population could not put solar on their residences due to several factors, including roof shading, tenant limitations, and lack of roof space.[205] Virtual net energy metering (community solar) was established to expand the opportunity to benefit from solar to this population. In 2015, legislation established a Community Solar Pilot Program overseen by the PSC. The PSC approved the first community solar tariffs in April 2017. As modified by legislation in 2018, the community solar pilot will last 7 years. The PSC implements the pilot program

[204] Maryland State Government Article, §9–20B–05.
[205] Supply Curves for Rooftop Solar PV-Generated Electricity for the United States, National Renewable Energy Laboratory, Nov. 2008. nrel.gov/docs/fy09osti/44073.pdf.

through regulations. Community solar capacity was issued in three categories: 1) open, with no restrictions on the number and type of subscribers; 2) small, brownfield, or other (S/B/O) for small arrays less than 500 kW on brownfields, landfills, and other (meaning primarily rooftop, but also open to other unique applications); and 3) LMI, requiring at least 30% of the array energy output to go to LMI households.

Next Steps

1) Change SEIF statute definition to allow HUD program participants.

2) Pursue statutory changes to allow ACP funding to conduct energy audits, weatherization, and energy efficiency upgrades. These items are prerequisites for solar installation and directly assist with overcoming key barriers to the deployment of solar systems in low-income households.

Action Item 19: Explore Solar Panel Recycling Best Practices

Solar panels will last between 20 and 40 years, and large-scale solar development in Maryland did not start until 2010. As such, solar modules will start collecting in large numbers between 2030 and 2050. At present, there is no recycling industry in the U.S. for silicon-based solar panels. Small-scale efforts are in place in Europe and the U.S., but the process is currently not cost-effective, and the high-value metals cannot be captured. Significant research is ongoing at universities like Arizona State University to find cost-effective ways to recover these metals.

As there is no current solar panel recycling industry at sufficient scale to address the future waste stream, Maryland has an excellent opportunity to be proactive in this area. Maryland could become the mid-Atlantic leader in this field and develop good, high-paying jobs. To do so, Maryland would need to study the logistics of the industry (what to do in the field and what to do at a centralized collection site), transportation modes and economics for the materials that needed to be shipped to a central site, chemical processes and waste streams that could result - with resulting geographic restrictions on the location of a central site - and many other concerns not discussed here. Such a study would be a multi-year effort and require engagement with neighboring states and the District of Columbia. If the study were favorable toward establishing a site (or sites), it would take a few years to plan, finance, build and commission them. Bottom line, if the state were to start now, the earliest a new industry would likely be in place would be 2030, about the beginning of the recycling glut.

Next Steps

Commission a joint working group on solar equipment recycling that includes MEA, MDE, Commerce, Maryland Environmental Service, Labor, and the Maryland Department of Planning. The state could also further consider targeted studies on recycling technologies, market barriers, job creation, and other elements to create new opportunities.

Action Item 20: Prepare for Offshore Wind Grid Integration and Storage Management

Maryland should carry out a comprehensive study to understand the steps and potential hurdles for successfully integrating OSW capacity in the PJM-Delmarva region. This study will need to be addressed in coordination with other states in the region, along with PJM. Understanding the regional context will be vital to address these issues. Integration of this nature is important to determine how to manage the expected influx of OSW generation off the northeast and mid-Atlantic coasts. The Delmarva peninsula is a potential interconnection point for multiple states, and understanding grid needs in this area will be necessary for expansion.

OSW turbines also present a unique opportunity for a value-add implementation of hydrogen gas storage assets that could aid Maryland in reducing GHG emissions from fossil sources. With sources like wind, there is the opportunity to utilize its carbon-free power to produce green hydrogen, which is then stored for future use. Due to their geographic location in a marine environment, energy storage in the form of electrolysis plants producing “green hydrogen” could be constructed to store excess OSW generation when supply exceeds demand. This hydrogen could then be sold to customers with behind-the-meter combustion or reaction generators and to the transportation industry as an alternative fuel to reduce overall reliance upon traditional fossil fuel sources and lower carbon footprint. A long-term opportunity for this type of energy storage is the integration of pipeline-grade hydrogen into existing natural gas infrastructure, which reduces the carbon footprint of the overall pipeline fuel mix. It should be noted, however, given current market conditions, “green hydrogen” production of this type does require dedicated capacity, without which it may not be economically viable.

Next Steps

This type of “green hydrogen” infrastructure should be examined in the context of Maryland’s offshore projects currently in development. Such a study would be used to understand the infrastructure, technological, and regulatory hurdles currently in place and could be done in conjunction with a previous suggested study to determine the hydrogen adaptability of the existing natural gas infrastructure.

Action Item 21: Determine the Potential for a Regional OREC Market

Maryland should work with D.C., Delaware,New Jersey, and potentially Pennsylvania, on a policy whitepaper investigating multi-state OREC procurements. This idea could ultimately lead to an increase in the number of ratepayers spread in multiple states and the District of Columbia, where large offshore wind projects could be socialized among a larger group. This effort could lead to decreased ratepayer impacts for Maryland ratepayers while potentially promoting economic development and job creation via a sustainable offshore wind supply chain.

Next Steps

Begin outreach to states interested in pooling resources for such procurements to inform an economic study on the issue.

Action Item 22: Modify Existing Incentives for Residential Energy Storage
The Maryland Energy Storage Income Tax Credit is effectively unavailable to LMI individuals, as LMI individuals are not likely to afford a $10,000+ energy storage system and thus can't take advantage of the tax credit. Depending on total tax liability, applicants with insufficient tax liabilities may not be able to claim the total value of the credit on their taxes. Under current program regulations, a tax credit received for a given tax year is not refundable and may not be rolled over to a different tax year, so any unused difference is lost. In addition, applicants sometimes have logistical difficulties claiming the tax credit on their taxes.

The amount of "lost" credits can be mitigated if the current tax credit were allowed to be refundable (i.e., applicants receive a tax refund for the unused portion of the tax credit certificate). Alternately, applicants could more efficiently utilize the credit if any unused value could be carried forward to future years. This idea would require a change in state law and, subsequently, COMAR regs and programmatic guidance.

Next Steps

1) Study a change to the storage incentive from a tax credit to a refundable tax credit. This change may make the program more accessible and valuable since it would not require a larger tax base, nor would it require higher upfront costs. Applicants would have more equitable access to the incentive regardless of tax liability, which could mean increased access by LMI individuals.

2) Evaluate options to more closely align tax credit with federal and state tax year filings. Consider options to allow unused credit to be carried across multiple tax years to make credit more accessible to applicants with low tax liability.

Action Item 23: Assess Potential In-state Deployment of Small Modular Reactors
To date, commercially available power reactors in the United States are of two varieties: Boiling Water Reactors (BWR) and Pressurized Water Reactors (PWR). These reactors tend to be large, above ground, capital intensive, and produce large amounts of electricity to the high voltage grid. Siting of these reactors is covered by 10 CFR Part 100. However, a new reactor concept is now under development, specifically the Small Modular Reactor (SMR). These reactors also tend to be BWR or PWR in design, are smaller, tend to be partially buried into the ground, and are modular, allowing multiple units to be placed together, but operated individually or in a group. These reactors have been designed to allow for long-term passive cooldown, minimizing or removing the need for electrical power. The burial of the reactor into the earth adds natural shielding in certain types of accidents and changes some aspects of the safety analysis.

While the NRC is responsible for siting decisions, Maryland agencies should become familiar with the safety aspects of this new generation of nuclear reactors and conduct generalized studies to determine which parts of the state would be unsuitable for siting consideration. Such a study should include cooperation with the DOE's Office of Nuclear Energy, the NRC, and companies having received NRC permission to design and build one or more SMR installations. Such a study would not be designed to supplant the NRC's responsibility for siting decisions. However, it would ensure Maryland is knowledgeable and ready to support siting decisions when the time comes.

Next Steps

An SMR feasibility study, including regulatory, siting, and safety issues, should be conducted with the intent to develop background material for key stakeholders, including the legislature, and should be undertaken by MEA. The PSC could also be requested to start a workgroup to explore these issues and provide a central point for the stakeholders that would be necessary to bring new SMRs to the state. The working group would also cover issues surrounding SMR safety, siting criteria, and a review of locations in Maryland that would be considered suitable for system siting and could potentially be done in concert with any studies being conducted. Funding could be requested from the government to conduct such a study, and coordination with the NRC should be desired in the event reactor siting criteria will be changed based on the design characteristics of SMRs and the new levels of threats being considered. This is a multi-year study and should include the Maryland Department of Planning (MDP), PSC, MEA, PPRP, University of Maryland (UMD), DOE, and support contractors with expertise in this area.

Action Item 24: Encourage the Development of Renewable Natural Gas

Solid waste from human activities is expected to grow by 70% by 2050. Natural gas companies in Maryland are promoting the use of RNG, which is methane gas produced by landfills, manure digesters, sewage treatment plants, and other biological sources, as a means of greening their fuel commodities.

RNG is a particularly attractive energy solution on Maryland's Eastern Shore, where waste from agriculture can be turned into a green energy commodity, creating new revenue streams for agricultural producers, and reducing runoff into the Chesapeake Bay. However, gas utilities may run up against limits in RNG availability and may face competition from sectors other than their traditional ratepayers who want to use RNG.

State and federal policies encourage carbon reductions from transportation fuels, and these incentives can be so lucrative that gas and electric utilities will be priced out. This issue could prove difficult for RNG's success as a source of low-carbon heating fuel or on-demand electricity. Regardless, this is a path pursued elsewhere in the United States and abroad, particularly in Europe. As costs come down and economies of scale increase, more in-state applications will arise. Additionally, the PSC recently approved two historic first tariffs and terms filed by BGE and WGL, respectively, for certified renewable natural gas originating in Maryland. These RNG proceedings allow state energy regulations, and infrastructure, to keep pace with the state's changing clean energy landscape. WGL's proceeding is still ongoing and BGE's RNG tariff was approved by the PSC.

Next Steps

Coordinate with the business community with the projects currently in development to better determine any assistance, regulatory barriers, or constraints that exist to accelerate the development and deployment of these technologies. Work with stakeholders to identify viable pilot and early adopter projects and provide grant programs to help accelerate these projects where possible.

Action Item 25: Establish State Fleet Clean Fuel Policy
The state should consider establishing minimum requirements for where a clean fuel vehicle should be used, fuel economy of remaining legacy fossil fuel vehicles, and infrastructure needs. DGS coordinates a state green purchasing committee that incorporates stakeholders across agencies. DBM and DGS coordinate the purchases with funding support from the SEIF.

Next Steps
MEA coordinates with DBM, DGS, and MDOT to identify model policies for state electric and alternative fuel use efficiency and other goals.

Action Item 26: Explore Alternative Fuel Vehicle Access to Tunnels
Current regulations restrict CNG, LNG, and propane vehicles from traveling through the Baltimore Harbor and Fort McHenry tunnels to no more than 150 pounds net weight of fuel, effectively serving as a ban on medium-heavy duty vehicles that utilize these fuels. Hydrogen-fueled vehicles will also eventually have to be considered once these vehicles start to be widely deployed. MEA has engaged with MDOT and its business units on revisiting this regulation. However, progress still needs to be made to come up with appropriate realignment of regulatory requirements.

Next Steps
MDOT and MEA coordinate to determine a path forward and determine if there are any further safety considerations.

Action Item 27: Consider Possible Adjustments to the RGGI Auction Proceeds Formula
Compared to other RGGI states, Maryland statute provides significantly lower RGGI-based investments in energy efficiency, amounting for 27% of the total, whereas the others typically approach 67%. Energy efficiency is a critical element in promoting reliability and resiliency by reducing demand on the grid. It also contributes significantly to GHG emissions reductions. If an increased percentage of RGGI revenue is to support LMI efficiency, conservation, renewable and clean energy programs, the reconsideration of the revenue allocation formula outlined in §9–20B–05 may be warranted, though it would require a determination for an alternate funding source for the state utility bill payment assistance programs.

In addition, §-20B-05 also requires a total of $7 million to be provided to the Commerce Department's Small, Minority, and Women-Owned Business account and a total of $8 million to the Labor department for apprenticeship training programs in the clean energy industry. This formula leaves little to no room to expand programs in either the energy efficiency category or renewable energy and climate change. Due to the constraints imposed by the formula, legislatively-mandated use in certain buckets by necessity will cause reductions in other programs in order to maintain alignment with the formula.

Next Steps

Begin conversations to determine whether or not additional allocations to LMI energy efficiency from the bill assistance category would be a net benefit to the low-income community compared to increased investment for additional efficiency, conservation, renewable and clean energy programs to support the LMI community.

Action Item 28: Revise the Energy Assurance Plan

A steady stream of reliable energy provides the foundation for a functioning modern society, and Maryland residents have come to expect minimal interruptions in their supply of electricity, transportation fuels and heating products. Energy supplies are not just a convenience, but have become a necessity for individuals and businesses. A prolonged interruption of the supply of basic energy or fuel (petroleum products, electricity, or natural gas) could result in significant harm to Maryland's public health, safety, economy and security. Although private firms supply energy commodities, the state's interest in providing for the welfare of its citizens gives it a role to play in helping firms assure the continued provision of energy and fuel. The EAP points the way to improving energy assurance in the state, and is intended to help mitigate the impacts of an energy supply interruption and enable the state to return to normal conditions as quickly as possible.

It is necessary to review the 2012 EAP, and develop a new plan based on the current state of the energy industry, with updated generation inventories, distribution assets, an analysis of current and projected energy markets, interdependencies, regulatory structures, environmental threats, and the outlook for the future. An updated EAP would consider the current conditions of existing assets and regulations to ensure the grid's reliability. Three State agencies — the MEA, MDEM, and the PSC — collaborated to develop the previous Maryland EAP. All three agencies would be critical partners in developing an updated EAP.

In tandem with an updated EAP, the state would benefit from an update of the Fuel Contingency Plan. This plan is the procedural document that stems from an EAP and is utilized by the SCF-12 to support and coordinate the state-level restoration of commodity fuels in affected areas during emergencies.

Next Steps

Initiate a comprehensive review of the EAP and coordination among MDEM, MEA, and the PSC to develop an updated and relevant plan in alignment with current policies and state needs.

Action Item 29: Introduce Natural Gas Efficiency Goal in EmPOWER
In 2021 Maryland embarked on an expansion of the natural gas infrastructure. The expansion will bring the benefits of natural gas services to new communities and will enable economic development through lower commodity costs. The existing infrastructure also presents opportunities to increase benefits to ratepayers through existing programs that accelerate the replacement of aging infrastructure. In addition, the over 1 million existing natural gas distribution service accounts can benefit from energy efficiency programs that improve consumption and usage of the system.[206] Some of these ratepayers have been incentivized to install more efficient natural gas equipment through the EmPOWER program.

The benefits of natural gas programs in EmPower have accrued without a natural gas energy efficiency goal in the program. Establishing a natural gas energy efficiency goal to pursue cost-effective energy efficiency programs across the Maryland natural gas system could expand the program's reach and increase benefits to ratepayers. The natural gas energy efficiency goal would also support other state initiatives to reduce emissions from higher emitting fuel sources. Establishing a natural gas energy efficiency goal and increased natural gas programming to meet the goal can also enhance the economy's resiliency. Efforts to improve the use of the natural gas system can reduce stress on the infrastructure and facilitate diversification in the fuel mix used by households and businesses, especially during critical hours.

Next Steps
MEA has started to pursue, through the stakeholder process at the PSC, advocating for the introduction of a modest gas efficiency goal, aligning efficiency standards in the gas sector with more widespread distribution of electricity.

Action Item 30: Adoption of Building Codes and Training
The state should accelerate the adoption of the latest energy-related building codes for Building Code Officials and Building Managers. The state should coordinate the creation of building code training programs for code officials, building managers, and others as required to match the three-year IECC program cycles.

Next Steps
MEA, Labor, local code officials, and other stakeholders should collaborate with national experts and other states to review options for further improving the efficacy of existing codes. Possible options for improvement include, but are not limited to, offering training for code professionals at the beginning of each new code cycle and undertaking a compliance study to identify any possible energy code implementation areas of opportunity. In addition, this group can consider potential stretch code options that could be voluntarily adopted by jurisdictions that can help facilitate accelerated decarbonization of buildings.

[206] Gas Choice Enrollment Report, December 2020, psc.state.md.us/gas/wp-content/uploads/sites/4/12-2020-Gas-Choice-Enrollment-Report.pdf.

Action Item 31: Assess Statewide Energy Burden
MEA, DHCD, and DHS should coordinate with OPC to measure and analyze energy burden, the percentage of income a household in Maryland pays toward energy costs, to best establish a reasonable goal for the state (e.g., no more than 5% of average household income).

Producing a study or annual metrics would establish a structured in-state measure of energy burden and provide a clearer picture to establish a goal. Researchers place the threshold for high energy burden at 6% or greater.[207] In Maryland, the average annual energy burden for low-income households is approximately 13%, compared to 2% for non-low-income households. Households that have very low incomes (0-75% of the federal poverty limit) have an average energy burden of 42% pre-subsidization (before engaging in any bill assistance programs).[208] The establishment of a baseline and monitoring over time to produce an acceptable goal is the main aim of this recommendation.

Next Steps
MEA, in conjunction with DHCD and OPC, should conduct a thorough review of energy burden in Maryland, develop approaches to monitoring energy burden continually, and generate a Maryland-specific definition that will allow tracking over time. As part of this greater understanding, the development of appropriate methodological approaches will be included.

Action Item 32: Develop the Offshore Wind Supply Chain in Maryland in Concert With Regional Partners

On Oct. 29, 2020,[209] Governor Hogan was joined by the Governors of Virginia and North Carolina in signing a Memorandum of Understanding (MOU) to create the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER).[210] The purpose of the SMART-POWER MOU is to advance offshore wind projects in the region and promote the Southeast and Mid-Atlantic United States as a hub for offshore wind energy and industry. The SMART-POWER states have committed to work together to increase regulatory certainty, encourage manufacturing of component parts, reduce project costs through supply chain development, share information and best practices, and promote synergy between industry and the signatory jurisdictions. MEA will work with its

[207] Colton R D 2011 Home energy affordability in New York: the affordability gap (2008–2010) Prepared for New York State Energy Research Development Authority (NYSERDA) Albany, New York Available online at: nyserda.ny.gov/-/media/Files/EDPPP/LIFE/Resources/2008-2010-affordability-gap.pdf Fisher, Sheehan and Colton 2013 Home energy affordability gap Public Finance and General Economics.
[208] APPRISE, 2018, Maryland Low-Income Market Characterization Report, Prepared for the Maryland Office of People's Counsel, opc.maryland.gov/Portals/0/Publications/reports/APPRISE%20Maryland%20Low-Income%20Market%20Characterization%20Report%20-%20Octber%202018.pdf?ver=2019-09-10-150223-853, 59.

[209] governor.maryland.gov/2020/10/29/maryland-north-carolina-and-virginia-announce-agreement-to-spur-offshore-wind-development/
[210] governor.maryland.gov/wp-content/uploads/2020/10/SMART-POWER-MOU_FINAL.pdf

partner states to operationalize the MOU, seeking common supply chain opportunities that create economic development opportunities for each signatory state.

Next Steps
Develop an interagency OSW Wind Steering Committee and a stakeholder workgroup, including key state agencies such as Commerce, DNR, Labor and the Governor's Office of Small, Minority and Women Business Affairs (GOSBA). Also, develop a "Maryland Offshore Wind Strategic Plan" document, which outlines Maryland's future efforts regarding offshore wind policy, regulations, future leasing areas, transmission, business supply chain and workforce development, research and development, environment, and wildlife. Encourage regional research to expand the knowledge base of ecological science related to offshore wind and other maritime activities. Finally, conduct a Regional Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis.

Action Item 33: Develop the State's Regulatory Framework for Carbon Capture and Sequestration
Engage with stakeholders to determine the best approach to a range of issues in preparation for the state to begin permanent transport and sequestration of CO_2. These issues include, but are not limited to, regulation, property rights for subterranean injection, permitting, liability protection for capture and storage facilities, and necessary environmental protections, among others. These issues are necessary to lay the groundwork for future carbon storage operations.

Next Steps
Begin a working group process managed by MEA, MGS, and DNR that brings together the necessary stakeholders to generate solutions, clarity, and paths forward on these issue areas.

Concluding Comments

Despite advancements in forecasting, we still do not have the ability to see precisely how Maryland's energy system will evolve. However, given the evolution of the system over the past decade, its current trajectory, and Maryland's future goals, it will be imperative to build a diverse, flexible, and highly adaptable energy system. These actions will all be crucial so the state's generation, distribution, and transmission elements are able to absorb and take advantage of new energy technologies as they come online over the next 20 years. The preceding recommendations will assist the state to move in that direction with the understanding that there will be more changes and adjustments to come. These issues will have to be revisited and addressed periodically to ensure appropriate advancement of our clean energy and climate goals quickly, cost-effectively, and equitably. Aiming for flexibility and diversity will allow the state to take advantage of changes in a dynamic system that have already materialized and strategically apply certain technologies where most applicable and beneficial.

Appendix A: Existing Recommendations of Note

The Governor's Renewable Energy Development and Siting (REDS) Task Force Report

In 2019, Governor Hogan issued an Executive Order forming the Task Force on Renewable Energy Development and Siting. That Task Force submitted its final report to the Governor in August of 2020. The report gives an overview of clean energy in the state and assesses the difficulties in promoting solar and wind energy resources' growth, with a primary focus on solar. That report is available through the Governor's website, and is meant to provide options to the Governor and the state to mitigate some of the land-use issues most projects must manage. There are several recommendations of note that could further solar and wind development. It should also be pointed out, some of the recommendations from both the interim and the final report were taken and acted on by the legislature.

Expand Suite of Incentive Programs

The report recommends specific consideration of the use of "tax credits to incentivize solar development on brownfields, degraded lands, parking canopies, rights-of-way, poultry housing and other existing infrastructure, including rooftops."[211] The report also recommends considering other types of incentives for siting solar on "preferred lands."[212] While the term "preferred lands" is not defined, the section implies they may be Maryland Opportunity Zones, rooftops, brownfields/ landfills, but not prime farming land.

Accelerate Rooftop Solar Permitting

The report recommends that Maryland agencies and departments such as MEA, Maryland DHCD, and Labor and Planning departments should work in partnership to convene stakeholder meetings with an Authority Having Jurisdiction (AHJ), major solar developers, and others to review possible permitting streamlining opportunities, and use the National Association of Counties' SolSmart Program to identify state and local governments that have successfully streamlined their solar permitting process.[213]

Evaluate and Promote Government Facility Solar Adoption

This report recommends that new construction or upgrades to state-owned buildings should be designed for solar installation. Possible solar deployment approaches on state-owned buildings include collaboration between DGS, MEA, and Interagency Commission on School Construction (IAC) to determine a process for evaluating solar for

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[211] Governor's Task Force on Renewable Energy Development and Siting, Final Report dated August 14, 2020, pg 19. See: governor.maryland.gov/wp-content/uploads/2020/09/REDS-Final-Report.pdf.
[212] Ibid., p 20.
[213] Ibid., p 28.

public facilities. MDOT and MEA should educate state agencies and local governments on options for solar as part of PPAs or energy-as-a-service financing approaches.[214]

Solar and Agriculture

Agrivoltaics is the co-development of the same land area for solar power and agriculture, keeping agricultural land in farm production while also benefiting from the use of solar panels.[215] Agrivoltaics allows the land to have dual use and provide a second cash crop, improving the project's overall economics. Some lands may be used as pastureland, allowing the land to regenerate while solar arrays are present. Other lands may be used to grow crops, as some have shown the ability to thrive in partial shade. This is a new field of practice, and lends the possibility for research and experimentation for opportunities suitable to Maryland. Maryland is home to many colleges and universities that could support this effort.

Microgrids

A "microgrid" is a series of interconnected facilities, generation assets, and advanced control equipment installed across a defined geographic area that is capable of operating in parallel to and disconnected from the overall utility grid.[216] It may be used to provide resilient power when the grid is down but may also be used to support the grid when requested by the local utility. Rooftop solar arrays can serve as a component of microgrid opportunities to individual buildings or a collection of buildings. MEA, PPRP, and the PSC should continue to work with utilities, cities, and counties to look for ways to encourage the development of public and private purpose microgrids. Lessons learned from these systems should be studied by MEA, PPRP, and the PSC and made available to the public.

Energy Storage

Energy storage connected to the electric grid can allow variable wind and solar energy to become firm, dispatchable power. It also increases the amount of wind and solar energy that can be connected to the grid without causing voltage instability. The integration of energy storage directly benefits the integration of clean, renewable energy sources to the grid. Maryland should take the lessons learned from the Energy Storage Pilot Program and develop a long-term strategy to incorporate energy storage and energy storage controls into the local electricity distribution systems' operation.

[214] Ibid., p 34.
[215] Ibid., p 55.
[216] Maryland Resiliency Through Microgrids Task Force, "Maryland Resiliency Through Microgrids Task Force Report," n.d,
energy.maryland.gov/Documents/MarylandResiliencyThroughMicrogridsTaskForceReport_000.pdf.

Appendix B: Generating Projects in the CPCN process

Case Year	Applicant/Facility name	Details of proposed plant	CPCN status	Case Number
2021	CPV Backbone Solar, LLC (Backbone Solar)	175 MW solar facility (Garrett County)	Pending	9663
2021	Costen Solar, Inc. (Costen Solar)	10.625 MW solar facility (Somerset County)	Pending	9662
2020	Kumquat & Citron Cleantech, LLC (Citron Solar)	7.2 MW solar facility (Wicomico County)	Withdrawn	9656
2020	PTR Holdco, LLC (Fairfield Solar)	30 MW solar facility (Harford County)	Approved	9652
2020	Point Reyes Energy Partners, LLC (Jade Meadow Solar)	19.84 MW solar facility (Allegany County)	Approved	9643
2020	New Market Solar, LLC	50 MW solar facility (Dorchester County)	Pending	9635
2019	Lightsource Renewable Energy Development, LLC	20 MW solar facility (St. Mary's County)	Withdrawn	9620
2019	Spectrum Solar, LLC	5.6 MW solar facility (Prince George's County)	Approved	9608
2019	Mattawoman Energy, LLC modifications to existing CPCN	859 MW facility (Prince George's County)	Cancelled	9330
2018	Morgnec Road Solar, LLC	45 MW solar facility (Kent County)	Suspended	9499
2018	Bluegrass Solar, LLC	80 MW solar facility (Queen Anne's County)	Approved	9496
2018	Kieffer Funk, LLC	11.8 MW solar facility (Washington County)	Approved	9495
2018	Citizens UB Solar, Inc.	8.172 MW solar facility (Carroll County)	Approved	9483
2018	CP Crane LLC	Modifications to existing CPCN (Baltimore County)	Approved	9482
2018	Cherrywood Solar I, LLC	202 MW solar facility (Caroline County)	Approved	9477

Appendix C: Generating Plants in Maryland

Ownership	Powerplant Name	Location	Fuel	Capacity (MW)	Year Online
AES Warrior Run Ltd. Partnership	Warrior Run	Allegany County, Md	Coal (plans to shut down by 2027)	180	1999
American Sugar Refining Co.	Domino Sugar	Baltimore City, Md	Natural Gas, Oil	17.5	1955

Brookfield Power	Deep Creek	Garrett County, Md	Water	20	1925
Calpine Corporation	Crisfield	Somerset County, Md	Oil	10.4	1968
Constellation Nuclear Energy Group	Calvert Cliffs	Calvert County, Md	Nuclear	1,705	1975
Covanta Montgomery, Inc	Montgomery County Resource Recovery	Montgomery County, Md	Municipal Solid Waste, Natural Gas	54	1995
Eastern Landfill Gas	Eastern Landfill	Baltimore County, Md	Landfill Gas	3	2006
Easton Utilities	Easton	Talbot County, Md	Oil, Natural Gas	68.9	1970
Environmental Liability Transfer/Hilco	Sparrows Point	Baltimore County, Md	Natural Gas, Oil	152.3	1949
Exelon Generation	Gould Street	Baltimore City, Md	Natural Gas	97	1952
	Conowingo	Harford County, Md	Water	572	1928
	Criterion Wind Project	Garrett County, Md	Wind	70	2011
	Perryman	Harford County, Md	Oil; Natural Gas	353.6	1972
	Westport	Baltimore City, Md	Natural Gas	115.8	1969
	Mount Saint Mary's - Solar	Frederick County, Md	Solar	16.1	2012
	Notch Cliff	Baltimore City, Md	Natural Gas	116.7	1969
	Philadelphia Road	Baltimore City,Md	Oil	60.9	1970
First Energy Corp	Riverside	Baltimore County, Md	Natural Gas; Oil	228	1951
First Solar Inc.	Hagerstown - Solar	Washington County, Md	Solar	20	2012
GenOn	Chalk Point	Prince George's County, Md	Oil, Coal (shuts down June 2021)	2,347	1964
	Dickerson	Montgomery County, Md	Gas, Oil	312	1959
Gestamp Wind	Roth Rock Wind Farm	Garrett County, Md	Wind	50	2010
Greenberg Gibbons Commercial	Solo Cup - Owings Mills	Baltimore County, Md	Natural Gas	11.2	2002
INGENCO	Newland Park Landfill	Wicomico County, Md	Landfill Gas	5.4	2007
Maryland Department of Public Safety And Corrections	Eastern Correctional Institution (ECI)	Somerset County, Md	Wood Chips, Oil	4.6	1987
Northeast MD Waste Disposal Authority	Gude Landfill	Montgomery County, Md	Landfill Gas	3	2009
NRG	FedEx Field Solar Facility	Prince George's County, Md	Solar	2	2011

	Vienna	Dorchester County, Md	Oil	170	1968
Old Dominion Electric Cooperative	Rock Springs	Cecil County, Md	Natural Gas	653.8	2003
Panda- Brandywine LP	Panda Brandywine	Prince George's County, Md	Natural Gas, Oil	230	1996
Pepco	National Institute of Health (NIH) Cogeneration Facility	Montgomery County, Md	Natural Gas	21.2	2004
Prince George's County	Brown Station Road	Prince George's County, Md	Landfill Gas	5.6	1987
Raven Power Holdings LLC	H.A. Wagner	Anne Arundel County, Md	Natural Gas, Coal, Oil	975.9	1959
	Brandon Shores	Anne Arundel County, Md	Coal	1,273	1984
Suez Energy North America	University of Maryland- College Park CHP Plant	Prince George's County, Md	Natural Gas, Oil	20.8	2003
Sunedison	University of Maryland - Eastern Shore - Solar	Somerset County, Md	Solar	2.1	2011
Town of Berlin	Berlin	Worcester County, Md	Natural gas	9	1961
Wheelabrator Environmental Systems	Wheelabrator Baltimore Refuse	Baltimore City, Md	Municipal Solid Waste	61.3	2001

Appendix D: Transmission Projects under the CPCN Process

Case year	Applicant/Details	County	CPCN status	Case Number
2021	Potomac Edison Doubs to Goose Creek Transmission Line Project	Frederick & Montgomery Counties	Pending	9669
2021	Baltimore Gas and Electric Company Five Forks to Windy Edge Transmission Line Project	Harford & Baltimore Counties	Pending	9658
2020	Baltimore Gas and Electric Company Bush River Crossing Transmission Line Project	Harford County	Approved	9642
2020	Baltimore Gas and Electric Company	Harford County	Approved	9636

	The Five Forks to Maryland/Pennsylvania Border Transmission Line Reliability Project			
2018	Baltimore Gas and Electric Company Key Crossing Reliability Initiative Transmission Line Project	Baltimore County and Anne Arundel County	Approved	9600

Appendix E: Existing MEA Energy Programs - Clean Energy and Resiliency[217]

Current State Initiatives

There is a broad array of incentives available to Marylanders to encourage the adoption of clean energy technologies. The following is a list of some options available, although it is not exhaustive.

Solar Initiatives

Solar programs have been developed to support residential and commercial-sized solar photovoltaic (PV) installations with the controls necessary to discourage free ridership. Projects with capacities larger than 500 kW were considered large enough such that economies of scale, when added to federal investment tax credits, depreciation, and solar REC sales, were sufficient to lower the cost of energy to a competitive range. MEA modifies incentive programs regularly to meet the evolving needs and realities of the solar market.

Clean Energy Rebate Program (CERP)
MEA currently funds and manages the CERP, which encourages solar PV, solar thermal, and geothermal installations on owned residential homes and commercial buildings. The residential incentive is a fixed dollar value for all system sizes, whereas the commercial incentive is variable; it decreases as system size increases to leverage economies of scale and discourage free ridership.

Dual Use Programs (Solar Canopies and Public Facility Solar Grants)
To minimize the amount of undeveloped land used solely for the installation of solar arrays, MEA currently provides two programs to encourage the installation of solar PV systems on infrastructure, which provides a "dual-use" for the property. These are the Solar Canopy Program and the Public Facility Solar Grant Program.

> **Solar Canopy Program**
> The Solar Canopy Program provides an incentive at a fixed dollar per kilowatt rate for installing a solar PV canopy over a parking structure, including parking lots and parking facilities, along with EV charging.
>
> **Public Facility Solar Grant Program**
> The Public Facility Solar Grant Program provides grant funding to state and local government agencies (including public educational facilities such as community colleges

[217] As of 2021.

and universities) to install solar arrays on existing facilities. The program offers capital support dollars for system components and installation costs. MEA has partnered with the Maryland Environmental Service (MES) to provide technical support to state and local government agencies (at no cost to the participant) to evaluate prospective sites for solar projects on built infrastructure, parking lots, landfills, brownfields and properties where the land has already been disturbed.

Community Solar LMI-PPA Program

The Community Solar Pilot Program, run by the PSC for 2017-2024, is designed to provide solar energy on a subscription basis to Maryland residents who cannot or elect not to install solar on their homes but still wish to benefit from the technology. In most cases, community solar energy is offered to customers through a power purchase agreement (PPA) model. A PPA is a legally binding contract under which a customer agrees to pay the owner of a solar PV array for the energy produced by the array over a specified period. The utility company then credits the subscriber's account for an equivalent amount of energy (or the cost equivalent at the retail rate).

MEA established the Community Solar LMI-PPA Grant Program to ensure the PSC-authorized pilot program's LMI provisions succeed and provide terms and conditions that benefit LMI communities. First, the program required short minimum contract terms or an easy, inexpensive way for a subscriber to terminate the contract prior to expiration. Second, the program provided incentive funds to help the system owners meet the Community Solar Pilot Program requirements to validate the LMI subscribers' income. The program also provided funds to guarantee long-term savings to LMI subscribers who remained in the program. These funds are paid to the system owners and are based on the Net Present Value of the long-term benefits guaranteed to LMI subscribers.

Resiliency Initiatives

Resiliency Hub Grant Program

In emergency situations when the power grid is shut down, it is imperative to regain access to some form of backup generation. Unfortunately, this backup generation capability is rare in the LMI community, which poses serious health risks given that their temperature-sensitive medications and refrigerated food can go bad during long-term grid outages. To help mitigate this problem, MEA established the Resiliency Hub Grant Program. The program's goal is to provide a solar-plus-energy storage solution to a central facility within an LMI neighborhood that is available to the neighborhood when the grid is down. This "resiliency hub" can provide lighting, limited refrigeration for temperature-sensitive medications, recharging capability for small battery-powered equipment (such as cell phones), and enough heating and cooling to keep people out of emergency rooms (normally 65-78 degrees F). Resiliency hubs are not supposed to be long-term shelters. They are not specifically designed for sleeping or food preparation, nor are they required to be specifically designed to withstand hazardous weather conditions.

Resilient Maryland Program

Obtaining support of critical decision-makers for an energy capital improvement project is necessary for it to move forward. Key stakeholders such as CEOS, CFOs, and other managers are necessary for project follow-through. Also critical to project success is the extension of favorable financing by capital providers so that the project is affordable and cost-effective. Provision of vetted and easily-understandable proof of concept to these parties is necessary for them to offer support. MEA has received feedback from many entities with which it has worked--Grantees, incentive applicants, policymakers, energy industry developers, stakeholders, and influencers, and many others-- that this proof-of-concept milestone is often the “make-or-break” point for a project’s probability of success. Organizations pursuing energy capital improvement projects that bolster community and/or facility resiliency, sustainability and efficiency have demonstrated higher success rates when project feasibility and design are more concretely defined and plans are more solidified prior to making a decision on whether or not to move forward. However, obtaining this proof of concept is often costly to an organization: detailed feasibility analysis, engineering, system design, financial modeling, and many other metrics that must be analyzed to solidify the concept and bring the project closer to “shovel-ready” status. When capital is not sufficient to conduct this analysis, the project is either significantly reduced in depth and quality (or foregone completely) and instead integrated as part of the equipment and installation services procurement process. Both circumstances can reveal roadblocks to project implementation that result in abandonment after significant staff time and capital have been spent and/or committed. This common hurdle is unlikely to be mitigated completely by market forces in the near future, especially as economic conditions remain uncertain in the wake of the COVID-19 pandemic.

In order to mitigate the problems surrounding proof of concept, MEA designed Resilient Maryland as a pilot program in FY20. The Program provides planning, engineering, and design capital to Maryland organizations pursuing resilient, sustainable, efficient energy solutions across a wide array of scales: communities/campuses, single facilities, resiliency hubs, and others. Program funds help Grantees offset the costs of producing various planning and design deliverables to solidify proof-of-concept and feasibility analysis of DER projects: community and campus scale microgrids, resilient facility power systems, advanced Combined Heat and Power (CHP) systems, and resiliency hub energy systems. The FY20 pilot was robustly successful. Due to its success and sufficiently-demonstrated demand, Resilient Maryland was integrated as a full MEA Program in FY21. The future near-term objective of the Program is to continue investing in the production proof-of-concept for promising energy projects, but also to identify replicable, scalable solutions that carry high market potential and attract sustained private capital investment. This effort will simultaneously further develop Maryland’s clean energy economy and bolster the resilience of the state’s energy grid.

Combined Heat and Power (CHP) Grant Program

MEA has offered the CHP grant since FY15 to encourage the adoption of highly-efficient CHP systems by commercial, critical infrastructure, industrial, agricultural, governmental, and other organizations that seek sustainable, efficient, economical energy management solutions for their operations that can also bolster facility resilience. Grantees have chosen to install CHP technologies for two primary reasons: to enhance the efficiency and sustainability of their operations that also reduces operating expenses, and to bolster operational resilience in the event of grid failure. This latter driver has become the dominant decision factor in the most recent iterations of the program as Maryland organizations have focused more on defining and quantifying the value of avoided operational downtime.

Energy Storage Tax Credit Program

The Energy Storage Income Tax Credit Program incentivizes energy storage system installations in Maryland. The incentive is available to both commercial and residential taxpayers and is calculated at 30% of total project costs, up to $5,000 for residential applicants and $150,000 for commercial applicants. A tax credit may be claimed for installations of various system technologies (e.g., chemical energy, mechanical energy, etc.) under different ownership models (owned/leased). All energy storage systems must store energy either for use as electrical energy at a later date or in a process that offsets electricity use at peak times.

Maryland Offshore Wind Capital Expenditure Program

This program provides grants to businesses presently in or entering the OSW supply chain. Funds are provided to offset the capital expenditure of businesses: for items related to business expansion, such as relocation costs, new construction of real property, and renovations; and for the purchase and installation of new or manufacturer-refurbished equipment at a new or existing property.

Maryland Offshore Wind Workforce Training Program

The OSW Workforce Training program provides grants to support new or existing workforce training centers entering the OSW industry by offsetting capital and operating expenses. Eligible capital investments include items such as: training center expansion (including relocation costs), new construction of real property, and renovations to existing real property; and purchase and installation of new or manufacturer-refurbished training-related equipment at a new or existing property. Eligible operating expenses include items such as curriculum development and/or training center certification or licensing, and operational costs to hold training courses of technical trade skill(s) and safety skills.

Biomass

Animal Waste to Energy (AWE) Program

While not presently active, AWE was offered by MEA from FY16 - FY19 to further the adoption of animal waste to energy systems by Maryland's businesses, government entities, and nonprofit organizations. Utilizing animal waste to generate renewable energy is a sustainable solution for organizations that must manage significant quantities of it. Some projects from prior years are still underway and are being monitored for success in achieving programmatic goals.

Animal Waste Technology Grants

The Maryland Department of Agriculture (MDA) manages the Animal Waste Technology Fund (AWT Fund), which provides grants to Maryland vendors, businesses, and individuals pursuing "innovative, economically feasible animal waste projects."[218] Some AWT projects focus on technology that can convert animal waste to energy.

Residential Clean Burning Wood Stove Rebate Program (CBWS)

MEA offers the CBWS to residents who install qualified pellet and wood burning stoves in their primary residences. Rebates are offered to residents for systems that meet minimum particulate emissions requirements and minimum energy efficiency ratings, as published by the U.S. Environmental Protection Agency.

Transportation-Related Collaborative Efforts

Maryland Zero Emission Electric Vehicle Infrastructure Council

In 2011, the Electric Vehicle Infrastructure Council (EVIC) was established by state legislation. EVIC was then expanded to include other ZEVs and fuel-cell EVs, resulting in the renamed Zero Emission Electric Vehicle Infrastructure Council (ZEEVIC). ZEEVIC is charged with developing policies and incentives to promote the adoption of ZEVs, raise awareness for ZEVs, and facilitate the integration of ZEVs into Maryland's transportation network. The council is chaired by MDOT but has the involvement of multiple government agencies, including MEA.

Medium and Heavy Duty (MHD) ZEV MOU

On July 14, 2020, Governor Larry Hogan signed a Memorandum of Understanding (MOU) alongside 14 other states governors and the Mayor of Washington DC to voluntarily work collaboratively to promote the market for electric medium- and heavy-duty (MHD) ZEVs within their jurisdictions. MDOT, MEA, and MDE have been coordinating on this initiative. In November 2020, MDE, MDOT, and MEA began conducting outreach to engage Maryland stakeholders to help develop the planning framework and to inform the multi-state action plan.

Northeast States Coordinated Air Use Management (NESCAUM) Multi-State ZEV Task Force/ZEV Action Plan

The Multi-State ZEV Task Force, facilitated by NESCAUM, was formed in 2013 when the governors of eight states, including Maryland, signed a Memorandum of Understanding committing to coordinated action to support successful implementation of state ZEV programs (New Jersey later joined in 2018, bringing the total to nine states).[219] These states set a collective goal of having 3.3 million ZEVs on their roadways by 2025, with MD having a state-specific goal

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[218] mda.maryland.gov/resource_conservation/Pages/innovative_technology.aspx

[219] Northeast States Coordinated Air Use Management, Zero-Emission Vehicles, nescaum.org/topics/zero-emission-vehicles/.

of 300,000 ZEVs by 2025. The Task Force released the first Multi-State ZEV Action Plan in 2014, which was then later updated in a 2018-2021 plan.